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TELEPHONE UNDERGROUND CONDUITS.

Of late years one of the most important features of telephone work in the larger towns and cities, and even in many of the smaller ones, has been the placing underground of wires and cables. Telephony depends essentially upon a multiplicity of circuits, and with the increase in the number also of exchanges requiring trunk lines, it has long been found best to underground even a moderately-sized network. Moreover, public opinion is steadfastly in favor of underground, and usually strongly opposed to overhead wires; while the improvement in conduit methods have facilitated construction and repair work. It has, therefore, appeared to us desirable in connection with the independent telephone meeting at Philadelphia next week—the programme of which we have given to our readers—to emphasize the importance of conduit work. In this issue, as a Special Supplement, appears a full, unabridged telephone conduit specification, drawn up for us by Mr. A. V. Abbott, the well-known telephone engineer. It not only constitutes a very interesting piece of technical literature, but will be found useful as a form upon which conduit contracts can be drawn up and approved by all the parties concerned in any municipality.

THE NATIONAL BUREAU OF STANDARDS.

In last week's issue appeared a description and illustration of the building which is to be constructed in the suburbs of Washington, for the National Bureau of Standards. As designed, it will have a splendid physical equipment. The plan is to have a separate power house about 100 feet distant from the main building. This is a far better arrangement than storing the hot and heavy running machinery in the basement, and then forever afterwards seeking to eliminate heat and vibration from the working rooms. For the extremely accurate work, which will doubtless form a small but relatively important part of the routine of the institution, a uniform temperature is a prime necessity, and the difficulties of maintaining constant temperature are exaggerated by the proximity of boilers and a smokestack in the same building.

The work of this very important and greatly needed National Bureau will necessarily be both national and international. From the national standpoint it will fix and determine all calibration in terms of the physical standards kept in its vaults, as Lares and Penates. From the international standpoint it will have to maintain a parity between its own standards and those of other nations generally; and, in particular, with the international standards whose depository is in Paris. Nothing perhaps more strikingly illustrates the breadth and humanity of higher civilization engendered by science, nurtured by technology and schooled by engineering than the fact that as the physical standards of a nation become more accurate and defined, they likewise become less purely national and more purely wide-world. In a certain sense the test and criterion of material civilization lies in the extent of universality of its measures. The old Mohammedan creed of unity of Diety and Prophetship finds a prototype in our time in the unity of science and her metrology. This is why the spread of the metric system means so much more than a mere change of units or even of a gain in simplicity. It is a necessity of the higher civilization that can only exist by co-operation of deeds and unity of thought.

It is interesting to see that pending the construction of its permanent home, a matter of many months, the Bureau is, and has for some time been, prepared to undertake the calibration and verification of much electric apparatus. This facility should be availed of by every manufacturer and every large user of electric apparatus.

THE PRIMARY BATTERY.

For some reason not easy to fathom, that old standby, the primary battery, has not received of late years anything like the attention that is its due. To be sure, the day of huge battery plants for telegraph and telephone systems is now gone by, but with the enormously increased use of miscellaneous electric appliances of all kinds there is a bigger field for a really good battery than there has ever been before. For the light intermittent current required for many uses we have, of course, the so-called dry cells of the Leclanche type, which are extraordinarily useful, but in spite of the immense number of batteries which have been brought out we have not yet anything which is similarly useful for work of a somewhat more serious description. Of fairly good batteries there are many, but the resources of modern chemistry and chemical industry ought to produce something far better than we yet have. There are many purposes for which a steady output of a few amperes would be exceedingly convenient if it could be obtained from a compact and convenient battery at moderate cost. To meet commercial requirements such a battery must derive its energy from moderately cheap materials so far as those which cannot readily be recovered are concerned. It must have an e. m. f. not less than a Leclanche cell, and must be able to hold it quite steadily until exhausted. These simple demands are easily met, but there are others more difficult. A successful battery must be neither smelly like a grove cell, nor slimy and troublesome like a gravity cell. It must be capable of pretty thorough sealing if provided with liquid electrolytes, and must neither run down on open circuit nor have a high internal resistance. If a Leclanche cell could be made to stand up for continuous service it would come nearer to filling the bill than any other yet devised, but in spite of many inventions it just misses a very large field of usefulness. The storage battery meets the requirements within its particular sphere, but wherever it can be conveniently charged current is also easily obtainable for general purposes, so that it cannot replace the primary battery to the best advantage. We believe it would be a good thing, at the next exhibition of things electrical, to make a special feature of the primary battery, with a thorough series of competing tests of those batteries now available. The results would at least be immensely instructive as to the present state of the art, and might serve to stimulate invention in a very useful direction. A thoroughly first-class battery may not be an epoch-making invention, but there is money in it to an amount often denied to inventions far more sensational.

HUGHES AND THE MICROPHONE.

From time to time the claim crops up, usually by implication, that Hughes, and not Berliner or Edison, was the prior discoverer of the microphonic principle. There is some reason for the persistence of this error, for Hughes' publication of his independent discovery was at the time heralded throughout the world, and public attention was caught by the statement that Hughes' microphone enabled the footfall of a fly to be magnified to the tramp of a horse. Moreover, Hughes generously offered his discovery to the world free of price, while the prior discoverers embodied the principle in patents, which in this country were withheld from issue for such long periods as to form a plausible basis for outspoken charges of fraud; and though these charges were not sustained in court, the situation naturally contributed to sentiment in favor of the claim for Hughes. Without in any manner wishing to detract from the credit due to Hughes as an independent discoverer of the microphonic principle, we consider that in the interest of scientific chronology it should be pointed out that priority must be assigned to both Berliner and Edison.

There is some reason to believe that Hughes began his investigation leading up to the discovery in December, 1877, and he privately exhibited some devices showing the microphonic principle in operation as early as January, 1878. The first public announcement, however, consisted in a communication made to the Royal Society by Prof. Huxley, in May, 1878. Preece, on May 23, 1878, in a lecture before the Society of Telegraph Engineers, described the investigations of Hughes; and on June 8, 1878, Hughes himself read a paper before the Physical Society on the subject. These several publications attracted much attention at the time, while on the other hand general knowledge of the discoveries of Berliner and Edison was lacking, by reason of the delay in issue of their U. S. patents. It should be said, however, that if the world had been so minded, it could readily have discerned Edison's work at least, in his British patent of 1877. Berliner made the discovery of the principle of microphonic action while practising with a Morse telegraph key, and a few days later, on April 14, 1877, filed in the United States Patent Office a caveat, in which he described the application of the principle to a telephonic apparatus, thus antedating Hughes more than a year in publication, and almost a year in discovery. The underlying patent describing the principle first enunciated in the Berliner caveat, and describing likewise an apparatus embodying the same, was not issued until 14 years later, and has been the subject of a *cause celebre* in patent litigation, which is yet in the courts.

The discovery of both Berliner and Hughes was of the broad microphonic principle not limited by the choice of any material. Edison, however, in an application filed July 20, 1877, described the carbon microphone, thus also antedating Hughes by some months in publication; and it has been claimed in certain patent litigation that Edison discovered the principle of the carbon microphone much earlier than the date of the above application. The Edison patent was not issued until fifteen years later—in 1892—and was then found to be invalid by reason of the fact that the British Edison patent on the same invention had previously expired. While Edison explained the theory of his microphone on the principle of "mass compression," and thus did not recognize in set phrase the microphonic principle, the fact remains that he did invent, prior to the Hughes publication, an instrument which embodied the same principle as that of the Hughes microphone. The priority of Berliner over Hughes does not appear, however, to be open to any qualification whatever. Prof. Hughes did so much pioneer work that even after this deduction is made from what has erroneously been attributed to him, his fame as a great electrical inventor stands permanently secure; and none may contest hi. credit as an independent discoverer of the microphone.

A VOLTAMETER FOR FEEBLE LONG-SUSTAINED ELECTRIC CURRENTS.

In the April number of the Proceedings of the Physical Society (London), there is a description of a single and seemingly useful form of voltameter that has important applications for special research. A glass tube, of about millimetre bore, is filled with mercury, except for a drop of decinormal aqueous solution of mercurous nitrate near the middle. The sealed ends of the tube have platinum electrodes included. The tube is set with the top electrode the anode. The current to be measured must not have a density of more than 1 centiampere per sq. cm. of tube section. With this density, the drop of solution will climb up the tube at the rate of about 1 mm. per diem. A tube 30 cms. long would, therefore, serve to register ampere-hours, or coulombs, at this density for nearly a year before it was time to upset the tube. Consequently, where a very feeble current has to be kept flowing, either steadily or intermittently, through a circuit for a long period of time, this simple apparatus would appear to be just the measuring instrument to employ. It seems unlikely that the instrument can be closely relied upon when shunted, not only on account of temperature-variation of resistance, but mainly because of c.e.m.f.

THE DEGREE OF CYCLIC MAGNETIZATION OF IRON WIRES AT HIGH FREQUENCIES.

An excellent paper on this subject appears in the May number of the "Philosophical Magazine." The question is one of considerable practical importance. Telephony, wireless telegraphy, and electro-therapy employ relatively high frequencies of alternating currents, and it may become a matter of consequence for special purposes to ensure and maintain the magnetic efficiency of iron cores at these frequencies. Dr. W. M. Varley has attacked the matter experimentally with the aid of the Braun tube, an instrument that has already done good service to technologists, and seems destined to do yet much more.

The Braun tube is a specially designed, and relatively long, Crookes tube excited in the regular manner to give a long thin beam of cathode rays, which impinge upon a relatively large fluorescent screen at the opposite end of the tube. In the normal quiescent condition of service, the cathode-ray beam produces a small, steady spot of light in the center of the screen; but by placing an electromagnet with its pole close to the tube near the origin of the cathode ray, every magnetic impulses in the electromagnet will be accompanied by a deflection of the cathode-ray beam and a movement of the luminous spot on the fluorescent screen. The lag in the cathode-ray deflection behind the magnetic is so extremely small as to be insignificant for all practical purposes. Consequently the Braun tube makes a particular kind of galvanometer devoid of lag or inertia.

Dr. Varley studied the deflection of this Braun tube galvanometer under the influence of the magnetism excited in cores formed of bundles of iron wire, under high-frequency oscillating currents The frequency was computed from the capacity and inductance of the discharging circuit, and the deflections due to the cyclic magnetization of the cores were compared with the deflections due to the same exciting solenoids with the cores removed. The cores tested were four in number, all 9 cms. long, and composed of carefully insulated separate iron wires. The total cross-section of each core was 0.15 sq. cm., made up of different numbers of different sizes of wire. In the coarsest wire core the wire had a diameter of 1 mm., while in the finest wire core the diameter was 0.22 mm., the other two cores having wire diameters of 0.71 and 0.525 mms. respectively. The frequencies were carried up to 128,000 cycles per second. The results show that with the core of finest wire, the cyclic magnetic intensity fell off about 20 per cent at 40,000 cycles, and about 25 per cent at 80,000 cycles. In the cores of larger sized wire, the falling off was much greater.

These results, assumed to be reliable, are in general accordance with the theory of the subject, and show the importance of using quarter-millimetre iron wire, at largest, in iron cores subjected to a frequency of many thousands of cycles per second. If the wire has a diameter much in excess of a quarter millimetre, a large fraction of the mass of the iron core is, for magnetic purposes, no better but rather worse, than so much paper. Just as electric waves of alternating current dip into a wire out of the enveloping ether, and can only penetrate to a certain depth of skin, if the frequency of alternation is high, so the magnetic waves of alternating current dip into an iron wire core out of the enveloping ether, and can only penetrate to a certain depth of skin, if the frequency of alternation is high. The higher the frequency, and the thicker the wire, in either case, the thinner will be the skin which will respond to the waves.

SYNCHRONIZING.

An article by Mr. J. M. Roman, printed last week, puts the methods and devices for synchronizing in most convenient form, both for instruction and for reference. In spite of many examples to the contrary, the operation of alternators in parallel has made comparatively slow headway in this country, and we fancy that a census of alternating plants in general would still show a surprisingly large number of instances in which machines are regularly operated on separate circuits, and load is snapped from one to the other when it is found convenient to run a less number of machines. The introduction of big polyphase generators has done much to break down the earlier prejudice, but it is not too much to say that synchronizing practice is still rather backward, and that the art of station operation by alternating currents still needs more attention than it receives. In spite of some exceedingly ingenious synchronizing apparatus, the ordinary phase lamp is the main reliance, and, perhaps, all in all, it is the most convenient and straightforward of all the methods yet proposed. Just why most American engineers persist in synchronizing with the lamps dark we have never been quite able to understand, since the European plan is somewhat safer and more sensitive. But this is a mere matter of detail compared with the improvements that can be made in the matter of accurate adjustment of voltage.

It is not enough that two alternators should be thrown together when at the same voltage and speed and accurately in phase. The final end to be attained is that the machines should go together without variations of voltage in the external voltage, and right at this point the trouble often comes. If the machines concerned have very good inherent regulation, they can be thrown in parallel, by the exercise of sufficient care, with such precision that the lights will scarcely blink; but in the average station it is quite too easy to tell when a new machine is being thrown on. Ordinarily in small stations one generator is pretty well loaded before another is thrown on, and when the load is redistributed there is a very perceptible change of voltage. A skillful operator can so adjust the voltages of the light and loaded machines prior to synchronization as to reduce this trouble to a minimum, but the European practice now and then adopted of loading the light machine on an artificial load prior to synchronizing is almost unknown in this country.

Ten years ago alternating-current practice was a stronghold of rough-and-ready methods. Any sort of regulation, or lack of it, would do. The lamps were specially planned to stand up under all kinds of abuse, and efficiency was utterly disregarded. It is small wonder that alternating methods, which were mostly bad, were held in disrepute, and that central station engineers looked upon the whole business with the most profound contempt. The times have changed since then, but the average alternating station has still much to learn. Gradually that most distinguished abomination, the house-to-house transformation system, has been obliterated; secondary mains have come into extensive use, machines are freely run in parallel, and lamps of better efficiency can be used.

But we are still very far from working the alternating distribution for all it is worth. In central station working, in particular, its present use is largely a makeshift, and there are very few places in which it is really getting a trial on its merits. The old controversy of alternating vs. continuous currents still rages like the ancient one between predestination and free-will. The continuous-current central station has worked out apparatus and methods for exact regulation to a point that is little short of marvellous, but in alternating current practice there still linger relics of old blunders that are rarely shaken off. The best alternating practice is to-day found in some of the large polyphase transmission plants, but they are too often handicapped by a market already provided with a well-developed, continuous-current system. The result is a series of compromises and makeshifts that give a fairly good but far from an ideal result. It is a great pity that nearly every large city is so conditioned that electricity cannot play its rightful part, but a mighty incubus of vested rights and capitalized blunders has the average municipality well in hand. As the question now stands, one has to seek not necessarily the most perfect methods, but those which can be grafted upon a huge existing investment with the least amount of change. A system built *de novo* in the light of present knowledge would yield economic results of a most startling character.

Programme of the Independent Telephone Convention.

Mr. Chas E. Wilson, general manager of the Keystone Telephone Company, of Philadelphia, sends us the following, which embodies further data as to the annual convention of the Independent telephonists to be held next week in Philadelphia:

The meeting of the Independent Telephone Association will be held at the Hotel Walton, Philadelphia, on June 24th, 25th and 26th.

The local committee has secured the large banquet room on the top floor of the hotel for their meetings. The officers' quarters have been secured on the floor below. Delegates will be charged the regular rates for accommodations while in the city, and for those who cannot get suitable quarters at the Walton accommodations can be had at the Continental Hotel, 9th and Chestnut streets, or the Colonnade Hotel, 15th and Chestnut streets. Owing to the fact that two of the largest hotels in the city are being torn down for the purpose of rebuilding at this time, it will be impossible for all to be accommodated at the Walton. The committee has made no arrangements for the representatives of the manufacturing and supply houses. Those who wish to make exhibits can get space on the ground floor of the Keystone Telephone Building at Second and Sansom streets, at a very nominal figure.

On the 24th of June, it is intended by the committee that after the business meeting the afternoon be given up to visit points of interest in and about the city, and also to visit the main exchange of the Keystone Telephone Company.

After the meeting on the 25th, at 2 o'clock, the committee has arranged for a tally-ho ride through the famous Wissahickon drive to Indian Rock and return.

On the 26th the committee has arranged for an excursion to Atlantic City, after the business meetings have been concluded, and they will leave about three o'clock on special cars. The drive in the Park and the excursion to Atlantic City will be at the expense of the local committee. The committee may be able to arrange for a theatre party on the night of the 24th, but are not positive about that as yet. So far as making exhibits is concerned, they have decided that it is best to let each representative make his own arrangements.

The Mayor will deliver an address of welcome immediately after the convention convenes on the 24th.

Meetings of Electrical Contractors.

We learn from Mr. W. H. Morton, secretary of the National Electrical Contractors' Association of the United States, that the annual meeting is to be held in July, at the Hotel Walton, Philadelphia, Pa. The board of directors will meet at the hall of the Franklin Institute, at 9 A. M., July 16. The first delegates' meeting will be called to order in the same hall, at 1:30 P. M., on that date. In the afternoon, a special boat will take the delegates and invited guests along the river front to Cramp's Shipyard, and to League Island. This boat will leave the Arch Street Wharf at 4:30, returning, will land at the Washington Park, at 6:30 P. M. A dinner for the delegates will be given at 7 P. M. On July 17th the delegates' meeting will be called to order at 2 P. M., on the Steel Pier, Atlantic City, New Jersey. A special train will leave Philadelphia for Atlantic City at 9 A. M., of July 17th. The entertainment committee will provide transportation to and from Atlantic City for the delegates, and the tickets will be arranged to allow the holders to return any time within six days, so that the delegates can remain in Atlantic City if they desire to do so. The convention will adjourn on the afternoon of July 17.

In connection with the above, we should note the programme of the semi-annual meeting of the Electrical Contractors' Association of New York. This meeting will be held at Albany on July 15th, under the auspices of the Eastern New York Electrical Contractors' Association. The headquarters of the association will be at the Hotel Ten Eyck. The directors' meeting will be held at 9 o'clock A. M., July 15th, and will be immediately followed by the meeting of the delegates. At 12 o'clock a trolley ride will be taken to Schenectady, and the works of the General Electric Company will be inspected. A lunch will be served at that place. It is proposed to return by the way of Troy and Watervliet, if the trolley road now in the course of construction is completed, otherwise to return direct to Albany. At 8 P. M. the delegates will leave by the steamboat "Adirondack" for the trip to New York.

Arrangements have been made to serve a banquet on the boat after leaving Albany. Speeches will be made by the members of the different associations, and Mr. Charles L. Eidlitz, president of the National Association, will act as toastmaster.

It is also expected that the directors of the National Association will be among the guests at the State meeting.

Important Underground Work for Brooklyn, N. Y.

Commissioner Dougherty, of the New York Department of Water Supply, Gas and Electricity, has sent a report to Mayor Low as to the placing of electric light wires and all electrical conductors underground in the Borough of Brooklyn.

In his report the Commissioner said: The department proposes that the heavy trolley feeder wires which line the sides of numerous streets or run under the elevated structures be removed, and be placed underground. If an area with a radius of two miles from the bridge be adopted, subways could be built within it before July 1, 1903, and the work already done is sufficient to indicate that if the plan be steadily pursued, the streets within a radius of two miles from the Brooklyn Bridge can be relieved of this overhead danger within the course of a year.

The following are the recommendations of the Commissioner:

That the following classes of overhead wires be removed within an area of two miles from the Brooklyn Bridge.

The trolley feeder wires of the Brooklyn Rapid Transit Railroad Company and of the Coney Island and Brooklyn Railroad Company. The Coney Island and Brooklyn Railroad Company has not yet constructed any subways. The Brooklyn Rapid Transit Company, with the next year, might easily complete construction of subways to such an extent as to relieve this portion of the borough from overhead trolley feed wires without incurring a financial burden of too serious a nature.

The Edison Electric Illuminating Company should remove its overhead wires from the same area, because it is doubtful whether it has the right to maintain them there at all, and because the wires carry a dangerously high electric current, and are one of the most serious menaces to life and property in the borough.

The New York and New Jersey Telephone Company should remove its overhead conductors from the same area. The work which it is proposing to do will enable it to achieve this much desired result within the same time. The telegraph and signal companies should also remove their wires.

With regard to the general subway question, Controller Grout said, last week, that he would make a protest against the contractors for the rapid transit tunnel being allowed the use of 70 additional ducts for electric wires. The claim of Controller Grout is that the subway contractors in the original contract received authority to place 70 ducts for the purpose of carrying electric wires and power wires for propelling cars, lighting, and heating. The Rapid Transit Commissioners gave the contractors the right to put in 70 additional ducts. Controller Grout argues that the contractors will never need the additional electric conduits, and that it is their purpose to sell electricity for light, heat and power.

Telephone Rates in Washington, D. C.

The U. S. Supreme Court, at Washington, has just passed in a rather indeterminate manner on telephone rates for the national capital. On June 30, 1898, Congress passed an act fixing the rates of telephone service in the District of Columbia, running from $25 to $50 a year, according to the number of telephones connected on one wire—the maximum sum was for a single telephone on a wire. The Chesapeake and Potomac Telephone Company defended suits brought to enforce the law on the ground that the rates were confiscatory, and the Supreme Court of the district held that they were. The Court of Appeals reversed the judgment, and the company appealed to the Supreme Court. Justice Brewer, in the opinion of the court, reviewed the history of the legislation fixing the rate of charges, and came to the conclusion that Congress had acted unadvisedly. The decrees of the lower courts were reversed, and the case was remanded to the District Supreme Court to further inquire as to the reasonableness of the rates in the light of the construction given the statute by the Supreme Court. The decision was supported by only four justices—Messrs. White, Harlan and McKenna dissenting, and Messrs. Gray and Brown taking no part.

Development of Independent Telephony in Philadelphia.

CONSIDERABLE space was given in ELECTRICAL WORLD AND ENGINEER of April 5, last, to an illustrated description of the development of independent telephony in Philadelphia at the hands of the Keystone Telephone Company. At that time attention was paid more particularly in our article to the "Main" exchange, and we are now able to present some data with regard to the "Race" exchange of the same corporation. This has now gone into operation, and will, therefore, be ready for inspection by those who attend the independent telephone convention at Philadelphia next week.

The First, or "Race," District Exchange has been equipped by the Kellogg Switchboard and Supply Company, of Chicago, and is a common battery multiple exchange. In general, the apparatus which is installed consists of 15 sections of multiple switchboard (each section consisting of six panels and being arranged for three operators' positions), one main distributing frame, one intermediate distributing frame, one relay rack which is used for mounting the relays in the line circuits, one relay rack for mounting the relays in the incoming trunk circuits, one chief operator's desk, one wire chief's desk, one manager's desk, and one information desk, and one complete power plant.

The multiple switchboard at present consists of four trunk and eleven subscribers' sections. Each section is arranged with apparatus for three operators, and has a capacity of 7,200 subscribers' multiple jacks, 240 outgoing trunk jacks with designation strips, and 300 answering jacks and answering lamps. A cable turning section is placed at the right end of the switchboard. From this cable turning section the switchboard sections grow in a direction from right to left. The four sections nearest to this cable turning section are incoming trunk sections. At the first position the trunk lines from the chief operator's desk and the wire chief's desk are located. The remaining eleven positions in these sections are each arranged for an incoming trunk operator, with 30 plug terminated incoming trunk lines. The first five of these eleven positions have not been furnished with equipment with this installation. The remaining six positions are each completely equipped. Arrangement has been made for switching all incoming calls received at any one of these positions to any desired position. By this arrangement, one operator can handle all the incoming business of the exchange during the night or the slack times of the day.

The fifth to the fifteenth sections are each arranged for an equipment for three subscribers' operators, with 15 pairs of connecting cords and 10 order wire circuits. Each position, excepting the three positions in the fifteenth section, has been completely equipped. Each cord equipment consists of two supervisory lamps, a listening key and a two-party line indicating ringing key.

Each of the fifteen sections is provided with an equipment of 3,200 subscribers' multiple jacks, 240 outgoing trunk jacks, 320 answering jacks and lamp jacks. The multiple lines are multiplied once in every section, and the outgoing trunk lines are multipled once in every two sections. The first and last subscriber's operator in each section is furnished with 100 answering jacks and 100 lamp jacks. The middle operator's position at each section has an equipment of 120 answering jacks and lamp jacks. One pilot lamp is located at each incoming trunk operator's position and two at each subscriber's operator's position. The lamp at a trunk operator's position lights whenever an incoming order wire call is received at that position when the operator's telephone plug is not inserted in the telephone jack; one pilot lamp at each subscriber's operator's position light whenever any line lamp at that position is lighted, and the other pilot lamp at the subscriber's operator's position lights at the end of conversation when the clearing out lamp, which is associated with the answering cord, is lighted.

FIG. 1.—RACE EXCHANGE, KEYSTONE TELEPHONE COMPANY, PHILADELHIA.

The chief operator's desk is provided with circuits for calling and conversing with the superintendent or manager; for conversation between the chief operator and any subscriber, and with any other desk operator, and with circuits which notify the chief operator of the rapidity and accuracy of the work of all of the exchange operators. The information desk and the manager's desk are each provided with three regular exchange lines and one line to each one of the other desks in the exchange.

The wire chief's desk is provided with apparatus for testing any line in the exchange, and for determinng the nature and location of any trouble which may arise on these lines. It is also provided with circuits which enable the wire chief to converse with any

exchange operator, with any subscriber and with the chief operator, information operator or manager.

The terminal room is located directly below the switchboard room. The terminal frame, main and intermediate distributing frames and relay rack are parallel to each other and are located as near to the switchboard as possible. The terminal frame is of a size large enough to accommodate forty 100 pair cable heads, but arrangement has been made so that additional iron work can be added later and the size increased so as to accommodate cable heads for

FIG. 2.—REAR OF SWITCHBOARD.

the ultimate number of lines. The present installation consists of the complete equipment of 40 cable heads.

The main distributing frame provides for an equipment of 4,160 lines, with provision for growth. The present equipment consists of terminals on both the line and switchboard uprights for 3,200 subscribers' multiple lines, 360 outgoing trunk lines, 360 incoming trunk lines and 120 miscellaneous lines.

The framework for the relay rack, which is provided, consists of iron work for 18 bays, each having a capacity for 200 pairs of lines, and cut-off relays and four strips of retardation coils, which are used in connection with the outgoing trunk lines. Arrangement

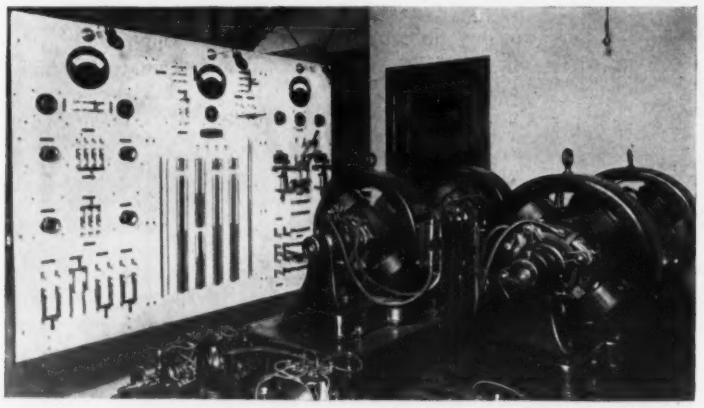


FIG. 3.—CHARGING SETS, RINGING MACHINES AND POWER BOARD.

has been made so that the size of this rack can be increased when desired.

The intermediate distributing frame provides for a capacity for 3,520 lines. The present outfit consists of the complete equipment of terminals for 3,200 subscribers' multiple lines and 160 miscellaneous lines.

The trunk relay rack has a capacity for the relays required in the incoming trunk circuits for eight incoming trunk operators.

The entire power plant, with the exception of the storage batteries, is located in a room adjoining the terminal room; while the batteries are located on the floor below the terminal room. Two Holtzer-Cabot specially-wound telephone generators have been provided for charging the storage batteries; each is run from the primary source of power, which is 220 volts direct current. Three ringing dynamotors with "busy back" and "don't answer" attachments have been furnished. Two are wound to run on the 220-volt mains, and the third is wound to run by current from the storage batteries. The ringing and charging machines are located on a machine pier made of white enameled brick. The power switchboard and fuseboard are mounted in one iron frame and are made of polished marble. The power board is provided with copper switches, which enable

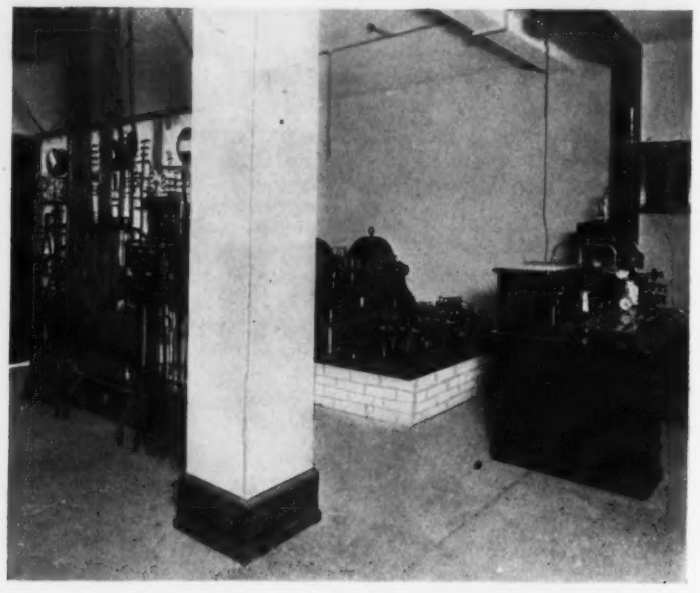


FIG. 4.—POWER MACHINES AND REAR OF SWITCHBOARD.

all desired changes in the power circuits to be made, Weston voltmeters and ammeters, which are capable of measuring all voltages and currents in the power circuits, rheostats, starting boxes and overload and underload circuit breakers. All fusing of power and switchboard circuits is done on the fuseboard. Under switchboard circuits are included, and cord circuits.

The storage battery plant consists of two sets of batteries of 11

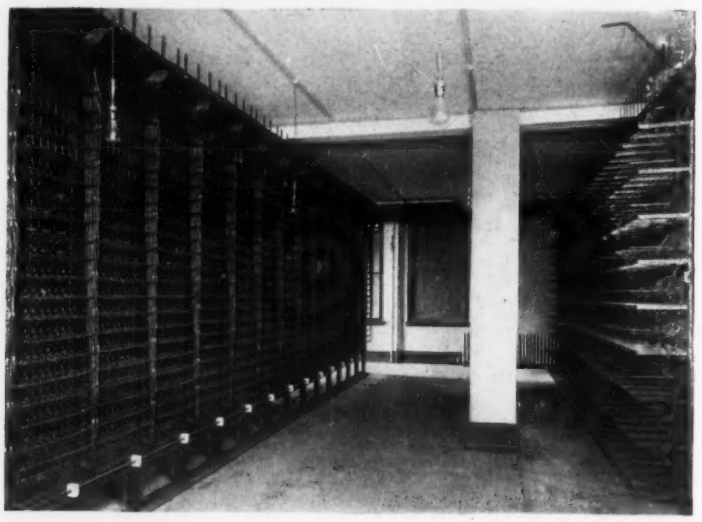


FIG. 5.—RACKS AND INTERMEDIATE DISTRIBUTING FRAME.

cells each. The battery tanks are lead lined and are provided with battery plates which are capable of supplying current for the present number of equipped lines, but are large enough to accommodate plates for the ultimate capacity of the exchange.

All power leads from the power board to the machines and batteries have been run in conduits located in the floor and the power leads from the power boards to the switchboard are run on an iron rack which is supported from the ceiling.

In addition to the above, we may repeat that the Keystone Telephone Company is building an exchange at Filbert and Preston Streets, West Philadelphia. Switchboard and instruments have been ordered,

as well as the conduits and all other material excepting cables, and orders for these will be placed shortly. It expects to construct during the year one exchange at Tenth street and Susquehanna avenue, one in Germantown and on in Kensington, making a total of six exchanges in Philadelphia County. The West Philadelphia exchange will have an ultimate capacity of 2,880 lines and 960 lines installed. The Germantown and Kensington exchanges will be duplicates of the West Philadelphia plant. The North exchange at Susquehanna Avenue will be a duplicate of the "Main" exchange. This year's work will require the laying of about 5,000,000 feet of conduit.

The rates of the company for service are: Unlimited business telephones per annum, $84; unlimited physicians' telephones per annum, $64; two-party line business telephones, $52; direct wire residence telephones, $48; two-party line residence telephones, $36; extension desk sets, $10. The officers of the company are well known men, whose names in some instances have been prominent in recent traction developments in Philadelphia. They are: President, Robt. H. Foerderer; vice-president, Jacob E. Ridgway; secretary and treasurer, W. H. Clark; general manager, C. E. Wilson; directors, R. H. Foerderer, Norman Grey, John M. Mack, Michael Murphy and J. E. Ridgway.

The company has a traffic agreement with the Keystone State Telephone and Telegraph Company, which gives it connection with the surrounding territory. That company is building in all suburban points around Philadelphia, and is building lines to connect with the principal exchanges in other cities. A submarine cable across the Delaware River will be completed in about two weeks, giving connection with Camden and all points in Camden and Gloucester counties, New Jersey, and the line is being surveyed to Atlantic City and Trenton to give connection wth the Interstate Telephone Company, of New Jersey, which controls practically all of the independent telephone plants in the State of New Jersey. The connection with the lines of the Maryland Telephone and Telegraph Company affords relations with all of the independent companies in Maryland and Delaware.

The Alternating Current Arc.

BY ERNST ADLER.

THOUGH illumination by alternating current arc lamps has already reached a high degree of perfection, the knowledge of the alternating current arc itself is rather incomplete. There are some features known to every engineer for which a satisfying explanation has not yet been offered, as, for instance, the fact that the alternating current arc requires a somewhat lower pressure than the direct current arc.

There are also other phenomena in which the physicist is more interested than the engineer. To this class belongs the peculiar property of the alternating arc with respect to different electrodes, iron and carbon, for example. Dr. Sahneka, of Vienna, discovered in 1894 that in such an arc direct currents also flow. This fact was discovered by the constant deflection of a magnetic needle situated in the vicinity of the arc. Later, the experiment was repeated by having in circuit a copper voltameter of the ordinary type. The deposition of copper on the cathode showed clearly that during the flow of alternating current a direct current also passes through the circuit. Messrs. Eichberg and Kallir have given an explanation for this phenomenon based on a number of experiments, including the taking of instantaneous photographs of the arc, the result showing that the arc has only one direction, acting as a kind of "electric valve," like the well-known rectifier devised by Pollak.

The present writer wishes to offer an explanation of both of these phenomena—an explanation which has not yet been given so far as he is aware. The idea occurred to the writer when reading the excellent paper on "Oscillations in High Potential Transmissions," read by Mr. C. P. Steinmetz at the Buffalo convention of the A. I. I. E., in August, 1901.

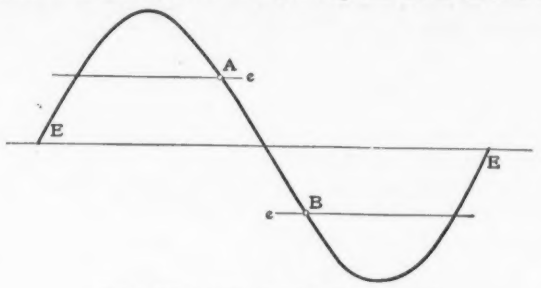
Mr. Steinmetz proved that when a circuit containing a self-inductance and capacity is interrupted, an oscillating current is produced. I believe that this principle may also find an application to the theory of the alternating current arc.

Referring to the accompanying sketch, Fig. 1, E is the alternating e.m.f. impressed on the circuit and e the counter e.m.f. of the arc. According to the opinion of a great number of scientists, this e. m. f. is due to some kind of electrochemical polarization. An alternating current arc is a circuit containing resistance, inductance and electrochemical polarization. Electrochemical polarization is a word without distinct meaning. There have been many efforts made to define strictly the real nature of electrochemical polarization in a satisfactory manner.[1] But without understanding the exact nature of electrochemical polarization we know all that it plays in alternating currents the part of a capacity. We do not know how many microfarads are equivalent to the electrochemical polarization of a given cell, but we often apply "water or liquid condensers" (first proposed by Mr. Swinburne), especially in starting single-phase induction motors.

It is very difficult to measure the resistance of the alternating-current arc, but we know that it is very great, compared with the inductance and with the condensance (equivalent to the amount of electrochemical polarization). Therefore the impedance of such an arc consists of two components, the ohmic resistance component, which preponderates, and the combined inductance and capacity component, which is far less. I say "capacity" instead of "capacity equivalent to the unknown amount of electrochemical polarization."

A slight consideration teaches us that the alternating-current arc must be a self-interrupting phenomenon, a view which is by no means new, but is held to by many authorities. We know that such an arc needs a certain voltage. If the impressed e.m.f. E (Fig. 1) is less than that necessary to overcome the counter electromotive force e, as in A and B, it follows that the arc is extinguished. This interruption occurs twice in the time of a complete cycle. We do not see the effect of this interruption, because the standard frequency in illumination circuits is too high; but with somewhat lower frequencies upon looking through a stroboscopic disk it is quite perceptible. With the standard frequency the air between the carbons has not time enough to cool, and the glowing gases retain their high temperature.

Steinmetz has shown that the interruption of a circuit containing self-induction and capacity produces an oscillating current. In the present case, we may say that an oscillating current is produced by the interruption of a circuit containing self-induction and electrochemical polarization. This interruption occurs twice per period, and each time an oscillating current is produced. The apparent resistance or impedance is no longer the resistance opposing to an alternating e.m.f., but is the resistance against a combination or superposition of an alternating e.m.f. with an oscillating one. As Mr. Steinmetz has pointed out in his classical treatise, "Theory and Calculation of Alternating Current Phenomena," that the impedance of a circuit containing self-induction and capacity is not the same for an alternating and for an oscillating current. The reactance pressures through self-induction and capacity are not quite watless, as in the common case, but have "negative energy components," which tend to diminish the ohmic resistance. This fact may be easily shown by calculating $L\frac{di}{dt}$ for an oscillating current of the general type $i = Ie - a\omega t \cos(\omega t - \phi)$. In a similar manner the energy component of capacity reactance is computed.



IMPRESSED AND COUNTER E. M. FS.

This principle granted, it is obvious that the resulting ohmic resistance of the arc is diminished. As stated above, the ohmic component is preponderant, and therefore the impedance becomes considerably less. Therefore the voltage necessary to work an alternating-current arc is smaller than that necessary to work a direct-current arc.

This method of considering the alternating-current arc as a source of oscillating currents offers also an explanation for the second phenomenon referred to above, i. e., the flowing of direct currents in the alternating-current arc between different electrodes.

We may suppose that the electrochemical polarization in such an arc has a value which fulfills (by chance or by necessity) the con-

[1] See recent paper by Mr. Reed, *Journal* of the Franklin Institute, April, 1902.

dition under which an oscillating current ceases to be a periodic one, but flows in the same direction, decreasing very rapidly.

This explanation for both of these properties is founded on a mere hypothesis. But a hypothesis holds good so long as it is possible to explain different phenomena in a concordant manner. To verify this supposition there should be made a thorough investigation in an experimental and in a theoretical direction. Both of these investigations are very difficult—the first owing to the complex nature of the phenomenon taking place during a very short time; and the second through the impossibility of calculating or measuring exactly the ohmic resistance, and by the present incompleteness of our knowledge of electrochemical polarization and its connection with capacity.

Storage Batteries.

At the recent Cincinnati Electric Light Convention, storage batteries were the subject of two queries in the "Question Box"—namely:

"How may storage batteries be protected, operating in connection with induction or synchronous apparatus, when interruptions occur on the transmission line? and what is the cost of maintenance and depreciation of storage batteries?"

Responding to the first-mentioned query, Mr. Lamar Lyndon, of New York, stated that storage batteries may be protected, when operated in connection with induction or synchronous apparatus, and prevented from discharging back through the same when interruptions occur on the transmission line, in several ways, depending on whether the machines are used for charging only, or whether they are to be used reversibly; that is, on useful discharge the energy from the battery converted back into alternating currents and fed into alternating systems.

In the first instance the ordinary underload circuit breaker, interposed between the charging machine and the battery, will protect the latter. A polarized relay circuit breaker or an underload circuit breaker of an ordinary type, will also meet the requirements. The polarized relay may be constructed with a permanent magnet, or the poles may be produced by an exciting coil connected to the battery terminals, as these give electromotive force in one direction only, whatever may be the direction of current flow.

The above-mentioned breakers cannot be used where the battery is to discharge back into the alternating line, passing through an inverted rotary converter or synchronous motor generator, since reversal of current direction in the direct-current side would cause the circuit to open.

The method most suitable for this case—which is a somewhat rare one in practice—is to make a spring-controlled circuit breaker to open the battery circuit, the latch being held in by the tongue of a small motor which receives current from the alternating transmission line, and which is similar to a well-known alternating voltage regulator. Those familiar with this device understand that the armature does not rotate continuously, but simply exerts a torque. The regulator mentioned is a reactive device, the torque being merely incidental and not in any wise useful; but a very small apparatus, made on the same lines and excited from a transformer such as is used in connection with station voltmeters could be made to operate the current breaker latch; nor would the complete combination be expensive, nor as complicated as the foregoing would indicate.

It may be added that the batteries in any case would not greatly need protection, as they would drive the converter or motor generator, as a motor and the counter electromotive force would prevent abnormal current flow; in fact, the current discharged by the battery would be only that necessary to drive the machine operating at no load, and the consequent energy loss would simply be that due to the friction and internal losses of the translating machine.

Mr. R. H. Pierce, of Chicago, said that if the object is to protect the battery, then it can best be protected by fuses or by some kind of circuit breaker having a time limit. It will not do to have the storage battery thrown out of service by an instant overload, even if this overload amounts to many times the capacity of the battery. On the other hand, we cannot afford to overload the battery for any length of time with such a heavy short circuit that it would warp the plates. In the latest installation of this kind made by Mr. Pierce, the battery was protected with copper fuses rated at about twice the one-hour discharge rate of the battery. This saved the battery, which had about 200-kilowatt capacity, which otherwise would have had to carry about 1000 kilowatts.

The one asking the question may have had in mind more particularly the protection of the apparatus than the protection of the battery. A serious trouble that has occurred, where a storage battery has been used with rotary transformers, has been that the rotary transformer when running with a light field has acted as an inverted rotary and has run away. When there is almost unlimited power in a battery, this may mean the destruction of the rotary unless it can be cut out of circuit. There are two ways of avoiding this: The first way is to have the rotary excited by the exciter, which is belted to the rotary or direct-coupled to it, so that as the speed increases the field of the rotary will strengthen and prevent running away. The other method is to have some kind of centrifugal speed-limiting device attached to the shaft of the rotary so that at a certain speed an electrical contact is made which automatically opens the switch controlling the rotary and puts it out of circuit.

In reply to the second question—as to the cost of maintenance and depreciation of storage batteries—Mr. Pierce said that in general, and assuming average conditions, if there be such, the positive plates should last three or four years. Should they last four years, the annual cost of maintaining the plates would amount to ten per cent. of the original cost of the plates. To this would have to be added the cost of making the changes of plates, which would depend upon circumstances. If the plates lasted three years, this would make the depreciation equivalent to fifteen per cent. These figures ought to cover all depreciation. Of course, the cost will be different where a battery is used for railway work and where it is used to its capacity for doing heavy lighting work, from the cost where it is used simply to float on the line in connection with lighting work. The above statement is based on what the central station manager would have to be prepared to face under average conditions.

As regards the maintenance, this depends upon the location of the battery—whether or not it can be inspected by a man that is also doing other work; and maintenance in the sense of putting the battery in good condition is covered by the item of depreciation. The figures given would probably not be accepted by the battery men. One battery in New York is guaranteed at six per cent. maintenance for three years, but Mr. Lyndon does not consider that a three years' maintenance guarantee amounts to anything. The best way to find out what the maintenance of a storage battery costs, is to see what the makers will guarantee on a ten-year contract under the actual working conditions. Mr. Lyndon said he installed a battery under these conditions where the maker agreed to maintain the battery for about five per cent. of the cost of the plates and tanks, but this is probably too low for anything like the average condition.

Mr. Lyndon considered the cost of maintenance and depreciation of storage batteries as a question that cannot possibly be answered without complete data as to the size of the battery, the work that it is doing, the quantity and density of the electrolyte, the character of the plates, and the minimum voltage at which they are allowed to discharge. If the battery is used for regulation, alternately charging and discharging at intervals not widely apart, the plates should have a comparatively thin layer of active material and, for a given quantity of active material, should have a considerable area exposed to the action of the electrolyte. If the batteries are to be used for storage purposes, being charged full during the hours of light load and discharged on the peaks, these same conditions should hold, provided the rate of discharge is rapid. On the other hand if the discharge is comparatively slow, a thick layer of active material will be more suitable.

Generally speaking, if a battery conform to the following specifications and limits of operation, the maintenance and depreciation should come within nine or ten per cent.: 1. Rate of charge or discharge never to exceed twelve amperes per square foot of active surface; the active surface to be considered as the length multiplied by the breadth by two, of each of the positive plates. The factor two is introduced to cover both sides of the plates. Of course, this is only an average value, applicable to most of the usual types. There are, however, batteries for which the rate given may be exceeded with safety.

2. The temperature at which they are operated never to exceed 100 degrees F.

3. The density of the electrolyte not to exceed 1.24 when battery is fully charged.

4. The quantity of electrolyte to be not less than ten pounds per 100 ampere hours of battery capacity.

5. The electrolyte to be pure and to contain no metals or lead dissolving acids.

6. The density and quantity of the electrolyte always to be maintained at the original values.

7. The battery never to be permitted to discharge below 1.85 volts per cell, the reading being taken when the normal current rate is passing, or 1.80 when the discharge is at the maximum permissible rate.

It will be seen that there are a number of conditions, but they are no more onerous than those required in the successful operation of any dynamo electric machine. It may be noted that the difficulties that have attended battery operation in this country have arisen largely from an attempt to perform work with too small a battery. Increased battery capacity not only reduces the depreciation and cost of maintenance, but increases the efficiency to a marked extent. The question, also, of proper quantity of electrolyte does not seem to have received the attention in this country that so important a factor deserves.

In addition to the requirements mentioned, others with reference to prevention of excessive overcharge, not allowing the cells to stand uncharged in the electrolyte, cleaning out the sediment in the bottom of cells, etc., are to be understood.

Wattmeters.

A large number of replies were received to queries in the "Question Box" of the National Electric Light Association relating to wattmeters. Mr. E. J. Bechtel, of Toledo, Ohio, considered that induction type meters are preferable to the commutator type under most conditions, and especially so in residences or where light loads are frequently used for long hour burning, and heavy loads are demanded at times. The induction type of meter requires less attention and inspection, and a good form is more reliable on constant potential or other low power factor loads. Mr. J. E. Barker, of El Paso, Tex., said that the induction meter has the same advantage over the commutator meter that the induction motor has over the commutator motor, in that there are no brushes to spark on the commutator, or get out of place. Moreover, the meters are easier to clean and repair, and repair parts are cheaper.

Mr. E. H. Jenkins, of San Antonio, Tex., favored the induction meter for the reasons that there are fewer chances of the meter stopping; it can be made just as accurate as the other type, and the moving parts are lighter. Mr. Geo. R. Greene, of Philadelphia, considered that the commutator type meter when properly compensated registers with commercial accuracy equally well on both direct and alternating-circuits of the usual frequency, and also on inductive and non-inductive loads. Recent improvements have tended greatly to reduce disadvantages due to commutator and brush troubles and to the trouble with jewels incident to the relatively heavy rotating parts. The disadvantages of the induction meter are that it is applicable to alternating currents only and must be adjusted to any large difference in frequency. Its general advantages over the commutator meter are: absence of commutator and brush troubles; reduced jewel troubles, due to lightness of moving parts; saving in shunt losses, these losses being one-third or less than in the case of the commutator meters; they can usually be repaired more easily and quickly, require less repairs and the cost of repair parts are less; they are more sensitive on light loads and remain calibrated longer. Mr. Greene stated that his company uses the commutator type meter on all direct-current circuits, and is now installing an induction type of meter on all alternating-current circuits.

Mr. F. P. Cox, of the General Electric Company, considers that in those stations where meters can receive but little attention and where inspection and adjustment cannot be made, it is probable that the greater revenue will result from the use of induction meters. The disadvantages of induction meters are that their curve does not approximate a straight line law as closely as that of a meter of the commutating type; they are particularly susceptible to changes in wave form; they are at a disadvantage with the commutating meter because they cannot also be used with direct currents; they are unquestionably subject to aging, which ultimately affects the light load accuracy; the induction meter must be looked upon as a device not yet thoroughly established, while this is not true of commutating meters; finally, induction meters as a class may be designated as "low torque" meters, and as such are liable to greater changes in accuracy. Mr. Cox believes that a discussion of the relative merits of induction and commutator currents will of necessity center on a discussion of torque.

Mr. O. J. Bushnell, of the Chicago Edison Company, stated that the advantages of the induction type meter are that they are more accurate on light and inductive loads, they have lighter moving parts and consequently less wear of jewels, and with no increasing friction due to brush contacts. Commutator meters have the advantage of stronger torque. Mr. J. H. Perkins, of Youngstown, Ohio, enumerated the advantages of commutator type meters, as consisting in greater independence of frequency and their applicability to both direct and alternating-current circuits. The advantages of the induction type meter are that they are dust-proof and are more accurate on light loads, both when new and after use; there is no commutator friction; they will not creep, and in one type manufactured there is no jewel bearing to give rise to inaccuracy. Upon the whole, Mr. Perkins considers, after one year's use of induction meters, that they show far better results than the commutator meter on every point except those noted in connection with the latter, and these are of small importance when compared with the general advantages of the induction meter.

On the subject of locating a meter on the consumer's premises, Mr. W. T. Oviatt said that a clean, dry place should be chosen, unexposed to vibration or sudden jars, and not more than 8 feet nor less than 4 feet from the floor. The meter should be protected by fuses, and there should be a service switch between the meter and the lights, so that the shunt coil will have current at all times there is current on the line. Mr. Geo. Greene, of Philadelphia, said that the meter should, if possible, be located on the lower floors of the buildings and in a position accessible at all reasonable times for reading and testing. Small closets, bathrooms, kitchens and damp, dusty places should be avoided. The meter should never be installed where it will be liable to unusual vibration. It should be placed about 6 feet above the floor and sufficient room left above and below it for removing the cover and jewel. Mr. O. J. Bushnell, of the Chicago Edison Company, gave advice similar to the above.

Messrs. F. L. Sargeant and W. T. Oviatt favored direct-reading dials, the former because of the lessened clerical work, and the latter because there is less liability to mistake in reading and the consumer can read his own meter, thus obviating a great many disputes as to bills. Mr. Geo. R. Greene considered that the direct-reading meters thus far placed on the market are subject to the disadvantage that the cylinders are apt to stick; otherwise they are preferable to the index dial type. Mr. O. J. Bushnell, of the Chicago Edison Company, said that the direct-current dial is very hard to read, and his company for this reason prefers the index dial. An anonymous communication criticized direct-reading dials, the statement being that they cause more trouble than index meter dials; moreover, direct-reading dials have been given a fair trial by both gas and water companies, and have been abandoned.

In answer to a query as to whether it is desirable to do away with all constants on meters, even if the meters cost more, there was a unanimity of opinion on the part of the five central station men who discussed the question, the consensus of opinion being that constants on meters cause more trouble than almost any other feature in the collection department of central stations, and that they should be eliminated. In eliminating constants, however, the value of the dials on larger sized meters need not be changed, as this is almost sure to result in confusion and consequent loss to the company in some instances.

Electric Lighting in Morocco.

There is but one electric lighting plant in Morocco, namely, at Tangiers. It is owned by the "Campania Transatlantic," the local agent being Mr. A. Ortenbach. Owing to the increased cost of coal and increased working expenses, the rates for current have recently been advanced. The present rates are: 1.20 pesetas per kw-hour by meter, or 9.60 pesetas per month for a 16-cp lamp, and 6.60 pesetas per month for a 10-cp lamp. The par value of the peseta is 20 cents. Street incandescent lamps, including renewals, cost 7 pesetas per month. The plant stops at 10 P. M. As to other luminants, in 1900 there were imported through the city of Tangiers candles to the value of $38,400, and petroleum to the value of $6,000.

New Electric Lighting at the University of Illinois.

BY MORGAN BROOKS.

THE recent revision of the National Electrical Code of the Fire Underwriters, increasing the limit of low voltage systems from 300 to 500 volts, has favored the introduction of a somewhat unusual method of distribution in lighting the five new buildings of the University of Illinois.

The plant is 440 volts alternating, and heretofore transformers, with a ratio of 4 to 1 have been used with 110-volt lamps. The new wiring has been done on the three-wire system, as shown by the accompanying diagram, the neutral connection being obtained by means of auto-transformers, of about one-fifth the size of regular

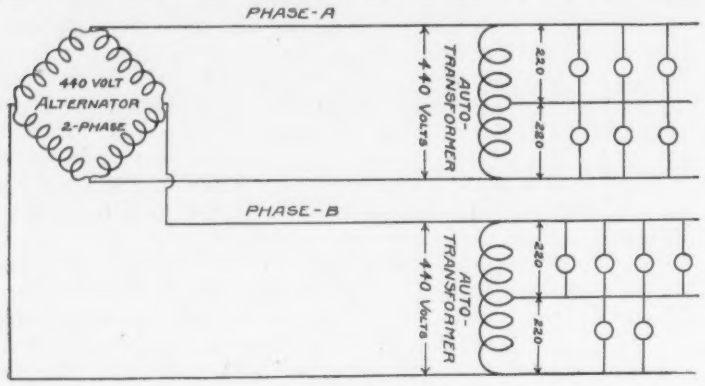


FIG. 1.—DIAGRAM OF CIRCUITS.

transformers serving the same number of lamps. The advantages of this method are evident, as there is not only a saving of four-fifths in the first cost of transformers and a corresponding saving in core losses, but an entire absence of the usual transformer drop at heavy loads. The regulation of the voltage between the two sides of the three-wire system by the auto-transformers has proved entirely satisfactory. At balanced loads, whether light or heavy, the transformer plays no part; with the most unequal distribution of load between the two sides of the system there was no noticeable difference in brilliancy of lamps, although about 4 per cent. measured difference in voltage. This difference is due to resistance drop only, as the transformers were wound with the two coils equally distributed over both branches of the magnetic circuit, eliminating all difficulty from magnetic leakage. For the 400 lamps (16-candle basis) installed in the new Gymnasium, there are in use two auto-transformers of 2 kilowatts capacity each, one in each phase as shown, and they have proved of ample capacity for the purpose.

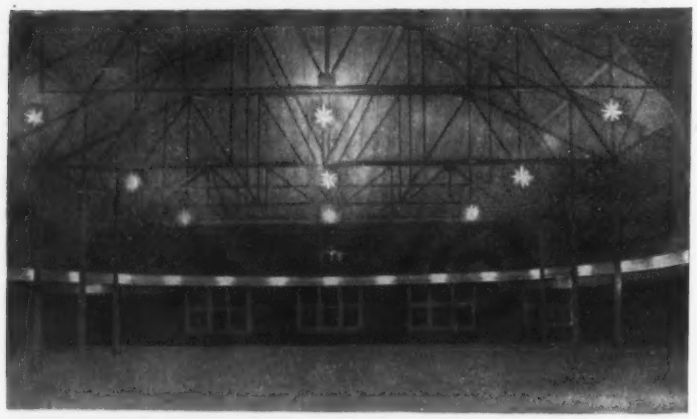


FIG. 2.—NERNST LAMPS IN NEW GYMNASIUM, UNIVERSITY OF ILLINOIS.

To protect the transformers from a possible overload it will readily be seen that a fuse cannot be used, but a special circuit-breaker operated by the current in the neutral, opens the main leads.

The use of the less-efficient 220-volt lamps in place of the 110-volt is of comparatively little importance owing to the relatively small number of hours of actual lighting, and also to the fact that during the heaviest lighting season the exhaust steam from the lighting plant is used for heating without supplying the demand for steam.

The new Gymnasium was first thrown open to public inspection on the evening of May 17th, when the swimming pool with incandescent lamps beneath the surface, the running track, and the spacious floor were much admired. The pleasure of the visitors was enhanced by the splendid lighting of twelve Nernst lamps, furnishing ample shadowless illumination for basket-ball or other indoor sports without the trying qualities of arc lamps.

While the conditions of college lighting—heavy possible demand with low load-factor—are particularly suited to the auto-transformer distribution system, nevertheless the plan tried at the University of Illinois has proved so successful that it would seem applicable to some small cities. The use of a 440-volt primary thus connected to a three-wire system, instead of the usual 1100-volt primary would secure the benefits claimed for direct-current distribution without sacrificing the advantages of alternating current for long distance lines and for power applications.

The Economic Design and Management of Telephone Exchanges—XII.

BY ARTHUR V. ABBOTT, C. E.

To determine the specific trunking capacity Q it is necessary to consider in some detail how trunk lines are handled, in order that the limitations surrounding them may be given full weight. When a subscriber calls the central office in which his line ends, the act of signaling displays an indicator (usually a drop or small incandescent lamp) placed in sight of an operator (termed a subscriber's or *A* operator) before whom the line of the particular subscriber terminates. On perceiving the signal the *A* operator inserts a plug into the answering jack of the subscriber calling, and switching her telephone set into communication with the cord attached to the plug placed in the jack gives the familiar request, "Number, please?" the subscriber replies stating the number of the party desired, together with the name or designation of the office in which the called party is to be found; for in all multi-office exchanges each office has its own special appellation. Learning that the called subscriber is in a foreign office the *A* operator must obtain a trunk line leading to the office desired and gain the attention of the operator (usually called a *B*, or incoming trunk operator) before whom this trunk line appears, in order that this second operator may call the wished-for party, and connect his line to the trunk line. When this is done the *A* operator in the originating office can establish communication by inserting into the trunk line jack the companion plug to the one already placed in the jack of the calling subscriber. There are two methods in common use whereby the *A* operator may gain the attention of the *B* operator. The first and oldest method requires the use of a signal for each trunk line placed in sight of the *B* operator, capable of being actuated by the *A* operator. Under this arrangement each *A* operator must either have a separate and independent set of trunks to each *B* operator, which necessitates an enormous trunk line plant, or if the same trunk lines appear or are multiplied in front of a number of *A* operators some means must be provided to inform the several operators which lines are in use, for if this is not done two operators may plug different parties on the same trunk line, and the consequent *double connection* results in "confusion worse confounded" to the exasperation of the subscribers and the humiliation of the operators. It is easy to devise an automatic signal associated with each trunk line placed before the *A* operators that shall inform them whenever a line is engaged. But such signals take up considerable space in the face of the switchboard, which cannot be spared in these days of five thousand line switchboards, wherein every sixteenth of an inch must be gained to make room for the multiple jacks. So it is usual to arrange that trunk lines in use may give the familiar *"busy test"* or emit a sharp click in the *A* operator's receiver when the jack rings with which they are associated are touched with the tip of the connecting plug. In the case of large and busy offices many trunk lines are needed, and during the rush hours of the day an operator may have to test a dozen or twenty lines before finding one that is disengaged. This takes considerable time at a period when it can be ill afforded; also the operator is quite liable to error, and in spite of the busy test may take engaged lines, all of which is exceedingly injurious to the service. But omitting errors from consideration the course of business is as follows: On receiving the subscriber's order the *A* operator tests the trunks leading to the desired office; selects one disengaged; inserts the connecting plug, signals on the trunk line, by ringing or otherwise. On perceiving the trunk line signal the *B*

operator restores the signal to its normal position, inserts an answering plug into the trunk line jack in the second office, switches her telephone set onto the cord, and asks the *A* operator for "Number." Then the *A* operator gives the *B* operator the order, on receiving which the *B* operator places the connecting plug into the jack of the called subscriber and rings.

To avoid the loss of time, errors and other imperfections of the *Signal Trunk System* the *Reverse Call Circuit Method* has been devised, and has practically supplanted the old plan in all but small offices. In this method one or more special pairs of wires are provided to each *B* operator's telephone to which the various *A* operators can connect their transmitter by the simple function of pressing a button, or *call circuit key.* The trunks extend from jacks in front of the *A* operators and end in cords and plugs before the *B* operators. The course of business is as follows: When an *A* operator receives an order from a foreign office she touches the proper call circuit button, and speaks the desired number directly into the ear of the proper *B* operator. The *B* operator picks up a plug attached to a disengaged trunk, inserts it into the jack of the desired party and rings, simultaneously pronouncing *back* over the call circuit to the *A* operator the number of the *trunk line selected,* and the *A* operator inserts the connecting plug into the jack of the trunk line thus designated. The simplicity, speed and accuracy of this plan leaves little to be desired for the transaction of trunk line business.

If the average length of time that a trunk line is in use during the transmission of messages be known, its practical specific trunking capacity can at once be calculated. The average time of occupancy must not only include the interval of time that parties are actually engaged in conversation, but must allow for the time taken by the *A* operator to obtain the trunk; for the *B* operator to find the jack of the called subscriber, and signal; for the called subscriber to answer

TABLE NO. 4.

ANALYSIS OF TIME OCCUPIED BY TRUNK LINE MESSAGES.

A SIGNAL TRUNKS.

1		Probable Time. 3	4
	2 *Minimum.*	*Average.*	*Maximum.*
A operator answers	2.0 sec.	5.0 sec.	7.0 sec.
B operator rings	5.0 sec.	12.0 sec.	20.0 sec.
Subscriber answers	10.0 sec.	15.0 sec.	30.0 sec.
Conversation	10.0 sec.	120.0 sec.	300.0 sec.
Disconnect	3.0 sec.	6.0 sec.	10.0 sec.
Total	30.0 sec.	158.0 sec.	367.0 sec.

B REVERSE CALL CIRCUIT TRUNKS.

A operator answers	2.0 sec.	3.0 sec.	5.0 sec.
B operator rings	3.0 sec.	5.0 sec.	10.0 sec.
Subscriber answers	10.0 sec.	15.0 sec.	30.0 sec.
Conversation	10.0 sec.	120.0 sec.	300.0 sec.
Disconnect	2.0 sec.	3.0 sec.	6.0 sec.
Total	27.0 sec.	146.0 sec.	351.0 sec.

the ring of his telephone bell; and finally, after conversation is completed, a sufficient interval to enable both operators to restore the trunk line to its normal condition, ready for the next message. Of all these various intervals, the time occupied by the subscriber in answering the telephone bell is the most uncertain factor. In the business hours of large cities answering is usually speedy and reliable, for business men are trained to prompt, quick action; and further, usually have a pretty fair idea of the inconvenience to which others are subjected by delay in replying, and the unjustness of such a course. Again, one or more employes are usually assigned the duty of responding to telephone messages, and general office discipline ensures immediate attention. Small city stores, and country town business houses come next on the list, with greatly extended and very variable times of answering, while residences, particularly those in small towns and villages, are telephonic terrors to their exchanges, in the utter irresponsibility displayed to telephone calls. In a case in mind (an actual fact) a worthy housewife finished a loaf of bread she was kneading, when the telephone bell rang, and a considerable fraction of an hour later when she answered, soundly berated the unfortunate operator because the calling party had not been compelled to await the completion of the breadmaking. The length of time occupied in conversation necessarily varies, between extremely wide limits, owing to the varying nature of business to be transacted, and while instances are on record of lines being held for an hour and a half, such are the exceptions that only emphasize statistics showing that scarcely five per cent of all messages last over five minutes, and some seventy per cent are completed in less than a minute and a half. City messages are shorter than country calls, and business communications much more terse and abrupt than those from residences. The times needed by the operators to find the trunk line, signal the called subscriber, and disconnect when conversation is completed are fairly regular and easily determinable by observation. In the foregoing table No. 4 the consumption of time for the various avocations indicated is given.

Columns 2, 3 and 4 of this table exhibit the probable consumption of time in the performance of the functions specified in column 1. The second column is the minimum time achieved with the very best service, column 3 the average time ordinarily to be counted on, while column 4 the maximum allowable time compatible with service even remotely satisfactory. From these statistics it would appear that on an average a trunk line is actually engaged a little less than three minutes per message, and that with an allowance of thirty seconds for lost time a specific trunking capacity of twenty messages per line per hour might be expected. Occasionally, under exceptionally good management, this amount of work is realized, or even slightly exceeded, but on the average fifteen calls per line per hour is all that can be calculated on, and even this quantity can only be handled in large and busy exchanges, under the most vigilant superintendence. The reason for so small a specific trunking capacity is not far to seek. In no business is the load factor so low as in telephony. Take, for example, the average subscriber's line, and assuming the average message to consume two minutes the line has a possible daily load factor of 720 messages. But even in the busiest offices of the largest city it is rare to find an average call rate of over thirty messages per station per day, or a load factor of only 4.15 per cent. For fourteen hours of the twenty-four most lines are absolutely idle, for few but residence telephones call outside of business hours. For trunk lines the load factor is somewhat better. From the preceding table it is seen that a trunk line would have a possible daily capacity of, say, 540 messages for signal trunks and 580 messages for call circuit systems. In well managed busy offices trunk lines will carry 150 messages per day, but taking large and small offices together, and allowing for inefficiency in management it is doubtful if the trunk line plants of all exchanges average a hundred messages per line per day. Thus the load factor might, under favorable circumstances, reach 26 to 27 per cent, but would only average from 15 to 18 per cent.

A telephone plant also differs markedly from most other electrical installations in its absolute inability to respond to any forcing. A dynamo will answer to a fifty per cent overload for a considerable period without injury, but a trunk line can by no possibility carry out *one message at once.* It is either working at *no* load or a *full* load; no other condition is, at present, conceivable. It is equally futile to press the operators, for the present rates of work are so taxing that almost the slightest excess so increases the nervous strain that the operators lose presence of mind, become confused and break down. There is also no momentum, no inertia to the parts of a telephone plant, and no possibility of any storage device that will enable even momentarily a rush of business to be carried over. When a subscriber calls he demands immediate attention and complains bitterly at the delay of a second in the response of the operator. To be told that a party in a foreign exchange could not be obtained because all the trunk lines were busy would invite an unquenchable storm of criticism from the modern telephone subscriber. So it is necessary to supply a trunk line plant so large as to be able to carry almost any conceivable overload. Not only must there be ample facilities to carry the peaks and rushes of the busy hours in the daily load, but the exigencies of holiday traffic, coupled with the extra pressure of bad weather, must be reckoned with, and provided for.

As the trunk line plant usually consists of cables buried in the ground it is not possible to put it in and out of service at pleasure, but it must be designed and installed a long time in advance of the necessity of its use, and once in place must remain till its term of service is over. There is one aspect, however, in which the trunk plant shows some elasticity. In cases where there are three or more offices in an exchange, it is always possible to connect any office indirectly with any other office by looping together in a roundabout fashion the lines through two or more offices, when the direct trunks between the pair of offices are exhausted or incapacitated. So, for the pre-

ceding reasons it is unsafe to assume a trunk line load, Q, of more than 150 messages per day from large and carefully managed offices, 100 messages per day from medium-sized offices, and 80 messages per day from small offices.

In a preceding paragraph it was shown that the office trunkage symbolized by T was given by the formula $\frac{R\,S'\,T'}{Q}$. Substituting in this expression the values of R and Q just deduced, and denoting with small numerals the limiting values of the literal factors, as is common with the sign for integration, the actual number of pairs of wires needed to carry the out-trunk traffic from any office to the rest of the exchange is obtained as follows:

$$\text{Number of Pairs} = \frac{q^{.85}_{.65}}{Q^{150}_{80}}\left[\frac{S\,T - S'\,T'}{S\,T} \times S'\,T' \pm \frac{P\,S'\,T'}{100}\right];$$

or approximately,

$$\text{Number of Pairs} = \frac{q^{.85}_{.65}}{Q^{150}_{80}}\left(\frac{S-S'}{S}\,S'\,T'\right)$$

This is the actual number of lines needed to carry the out-trunk traffic, but experience has demonstrated the wisdom of installing a slight excess in trunk line plant over and above the calculated number needed, that may act as a factor of safety, to care for unexpected fluctuations in traffic, and provide for possible growth.

If n represent the excess pairs advisable to thus install for each office and N the number of offices in the exchange, then $n\ (N\text{-}1)$ is the total excess trunkage. The indications of practice are that in small offices where the load fluctuations are likely to be severe, and there is a probability of rapid growth n should have a value of from 3 to 5, while in large offices with many lines, steadier loading, and slower growth, it may be as low as .5. When signal trunks are employed the true trunkage T will be the sum of the actual pairs needed plus the excess pairs, or,

$$T = \frac{q^{.85}_{.65}}{Q^{150}_{80}}\left[\frac{S\,T - S'\,T'}{S\,T} \times S'\,T' \pm \frac{P\,S'\,T'}{100}\right] + N^{5}_{.5}\,(N-1)$$

or approximately,

$$T = \frac{q^{.85}_{.65}}{Q^{150}_{80}}\left(\frac{S-S'}{S}\,S'\,T'\right) + N^{5}_{.5}\,(N-1).$$

In these expressions there is no allowance for the necessary pairs of wires to serve for call circuits to the B operators when the reverse call circuit system is employed. Evidently there must be at least one call circuit from the given office to each of the others, so there will be at least $N-1$ call circuits, from the office aspect, and possibly more if the volume of out trunk traffic demands. With the call circuit system good practice shows that a B operator can handle reasonably 3000 message per day. Therefore the out-trunk traffic divided by 3000 indicates the number of order wires needed from purely a *traffic* standpoint. Using the expression previously deduced for the out-trunk traffic, and dividing the same by 3000 the number of pairs needed for call circuit traffic is developed as follows:

$$\text{Call circuit pairs} = q^{.85}_{.65}\left(\frac{S\,T - S'\,T'}{3{,}000\,S\,T}\,S'\,T' \pm \frac{P(S'\,T')}{300{,}000}\right);$$

or approximately,

$$\text{Call circuit pairs} = q^{.85}_{.65}\left(\frac{S-S'}{3{,}000\,S}\,S'\,T'\right)$$

Now if the above result is *less* than $N-1$ then $N-1$ pairs must be employed, or if it be greater, then the value of the formula must be taken; algebraically this is stated as follows:

Call circuit pairs =

$$N-1+q^{.85}_{.65}\left(\frac{S\,T - S'\,T'}{3{,}000\,S\,T}\,S'\,T' \pm \frac{P(S'\,T')}{300{,}000}\right) - [N-1]$$

or approximately,

$$\text{Call circuit pairs} = N-1+q^{.85}_{.65}\left(\frac{S-S'}{3{,}000\,S}\,S'\,T'\right) - [N-1]$$

the quantity in the brackets being taken only in its arithmetical sense as a positive quantity. The complete expression for the trunkage from any office to the whole of the rest of the exchange thus becomes for reverse call circuit system:

$$T = \frac{q^{.85}_{.65}}{Q^{150}_{80}}\left[\frac{S\,T - S'\,T'}{S\,T}\,S\,T' \pm \frac{P(S'\,T')}{100} + N^{5}_{.5}\,(N-1)\right]$$

$$+ N - 1 + q^{.85}_{.65}\left(\frac{S\,T - S'\,T'}{3{,}000\,S\,T}\,S\,T' \pm \frac{P\,S'\,T'}{300{,}000}\right) - N - 1$$

or approximately,

$$T = \frac{q^{.85}_{.65}}{Q^{150}_{80}}\left(\frac{S-S'}{S}\,S'\,T' + N^{5}_{.5}\,(N-1)\right) + \left[N-1+q^{.85}_{.65}\left(\frac{S-S'}{3{,}000\,S}\,S'\,T\right) - (N-1)\right]$$

To ascertain the complete trunkage for the entire territory, the preceding expression must be applied to each office in the exchange successively, thus obtaining the trunkage for each one, and finally the summation of all these separate results will give the desired total trunkage.

In order to complete the design for an interlacing trunk system it is necessary to know the number of trunks and call circuits from each office to every other office, the offices thus being taken in pairs. The preceding formula can be used for this purpose, only in this case S is the sum of the sub-stations in the two offices under consideration, while S' is the stations in the office *from* which the trunk lines are to extend, T is the average originating traffic in both offices, and T' is the originating traffic in the office S'.

It is often urged that a complete system of this kind requires the expenditure of more wire plant than the business will justify, and that a saving could be made by resorting to indirect trunking, or the transmission of messages from one office through a second office to a third office. When the daily business is very small and the distance between offices great the employment of signal trunks instead of the call circuit system will make a justifiable saving in wire plant. But experience has shown that the resort to indirect trunking is never an economy. The time consumed in sending trunk messages through three operators, and the concomitant blunders, injures the service far more than can be counterbalanced by the annual saving in cost of a direct trunk line in all ordinary cases. Signal trunks can, on a pinch, be designed to serve as both outgoing and incoming trunks in both offices, and it must be a very small office, in a very small exchange, that will not transact a hundred messages a day, an office of twenty-five lines should do more than this, and it is rare that so small an establishment would pay under any circumstances.

New York Electrical Society's Annual Meeting.

There was a large attendance at the dinner of the New York Electrical Society, at the Café Boulevard, on June 12. Over a hundred were present. After dinner was held the annual meeting for the election of officers, which resulted as follows: President, Dr. Samuel Sheldon; vice-presidents, H. A. Lardner (re-elected), Geo. Herbert Condict (re-elected), H. V. A. Parsell (re-elected), W. I. Donshea, Hobart D. Betts and W. S. Barstow; secretary, G. H. Guy (re-elected); treasurer, H. A. Sinclair (re-elected).

The secretary's report showed that the year started with 611 members; 184 members have been elected during the year; 17 have resigned, and 265 have been struck off the rolls for non-payment of dues. This leaves an existing solid membership of 513, the best the society has had in years. The secretary referred to the pamphlet which has just been issued by the society, containing a list of meetings held since 1886, the new by-laws and constitution, and full list of members. The report of the treasurer showed that there was a balance in the treasury of $206.77.

After the business of the meeting was concluded the musical programme provided for the evening was entered upon. An excellent selection of pieces was played by the Hungarian band. The treat of the evening, however, was the singing of Mr. Harry T. Burleigh, of the St. George's choir. This rising baritone created unbounded enthusiam by his artistic rendering of several songs, in all of which—and notably in "Shades of the Palm," from "Florodora"—the rich and sympathic quality of his rare voice was admirably displayed. The evening was pronounced to be one of the most delightful occasions the society has ever enjoyed.

Convention of the Canadian Electrical Association.

The Canadian Electrical Association met for the twelfth time in convention at the City of Quebec, on Wednesday, Thursday and Friday, June 11th, 12th and 13th, and proved to be one of the most important in the history of the Association, the attendance of members and guests being the largest on record. Everything which could possibly be done for the comfort and entertainment of the Association was taken care of by the local committee, consisting of Messrs. Edward Slade, G. U. G. Holman, Louis Burran, A. R. Henry, Ed. A. Evans, Edw. Blair, J. S. Bosse and A. Dodge.

The social features arranged by the committee consisted of the annual banquet; a visit to the famous Shrine of Ste. Anne de Beaupre; Montmorency Falls and Kent House, and to the power house of the Quebec R. L. & P. Co. at Montmorency; a band concert by the Royal Canadian Artillery Band; a visit to the sub-stations of the Quebec-Jacqués Cartier Electric Company, and the Quebec Railway Light and Power Company; and, at the invitation of Mr. Frederic Nicholls, second vice-president and general manager of the Canadian General Electric Company, Ltd., a trip by steamer was given around the Island of Orleans, visiting the docks, harbor and site of the new Quebec bridge.

The first session of the convention was opened in the Chateau Frontenac on Wednesday morning with the President, Mr. P. G. Gossler, of Montreal, in the chair. Mr. George Tanguay, pro-mayor in the absence of Hon. S. N. Parent, addressed the Association in the name of the citizens of Quebec, and welcomed them to the ancient capital. He hoped that their stay in the city would be pleasant as well as a beneficial one, and that they would carry away with them a favorable recollection of their trip to Quebec. Mr. A. A. Dion, of Ottawa, on behalf of the Association, replied to the address of welcome and thanked Mr. Tanguay for the pleasant reception tendered them, and felt assured that their stay in Quebec, whose hospitality was proverbial, would be most enjoyable to all of them.

President Gossler delivered an interesting annual address in which he dealt with the question of the early development of electric power transmission in Canada; the aims and objects of the Association; legislation; inspection of electrical installations; the expansion of the business of electrical companies, and other items of minor importance.

He spoke of the particular appropriateness of meeting in the city of Quebec which was so closely connected not alone with the early settlement of the continent but also with the extremely early history of electric power transmission power development in the country. It was only necessary to look around them to find evidences of the abundant courage, foresight and energy which had brought to such successful completion such undertakings as the transmission of electric power from Montmorency Falls, at a time when high tension apparatus and lines used for the supply of commercial light and power were looked upon with some doubt, and considered by many as being an experiment. He felt safe in saying the installation of the Montmorency plant was the first high-tension system put into commercial use in this country.

He said one of the objects of this organization, as set forth by the constitution, is to promote the interests of those engaged in any electrical enterprise; to sucessfully secure this object its influence must be far reaching, and all companies, firms and persons interested in electrical enterprises should be related to each other through the medium of the Association; and the steady increase in membership in the last few years and the very marked widening of interest justified the Association in expecting that within a comparatively short time all these interests would be represented on the membership roll.

He was pleased to say that during the past year no legislation detrimental to electrical interests had been passed, which was largely due to the Asociation and its committees; yet the fact must not be overlooked that there was what he termed an undercurrent pointing to legislation by which many companies now existing and much invested capital would be deprived of rights and protection which were theirs legitimately. He deemed it his duty to bring to the attention of the Association the fact that evidence had, during the past year, been given in arbitrations required by the Conmee Act, which could not do other than have a tendency towards depreciation of the value of plants below the point which this Association would approve of. The promotion of the interests of its members was clearly the obligation and duty of the Association and such publicly-expressed opinions as might have a tendency to put other than a fair value on the properties of electrical companies should be discountenanced and discredited.

Special attention was called to the report of the Committee to Confer with the Board of Fire Underwriters, from which it was noted that there is an effort by the Board of Fire Underwriters to force upon one of the largest cities in the country the expense and responsibility of establishing a system of inspection for electrical installations.

The President thought the Association would agree than an efficient and thorough periodic inspection of all electrical installations was necessary and desirable, but the cost of this inspection must not be made a burden to the customers of electrical companies; otherwise the rapid development of electricity for commercial and domestic uses would be hindered. He felt strongly that electrical inspection bureaus should be established by and maintained at the expense of the Fire Underwriters, and thereby the interests of all parties would be best served.

A natural reduction in prices for lighting and power would be the result of developing business along the lines being successfully advocated in some of the cities—the limitation of the use of electric current for manufacturing purposes to the hours when there is practically no demand upon the supply station for meeting the lighting requirements, in other words, to the daylight hours. The disadvantages of the peak load characteristic of practically all supply plants, some years ago, and still of the majority of lighting and power plants, were known only too well to all of those present.

The idea that it is profitable for many, if not all, manufacturers to work only during the daylight hours is gaining ground rapidly; the best evidence of which is the fact that contracts are continually being entered into which do not require the supply of all or part of the power during the hours when the need of illumination makes the greatest demand upon an electrical plant. Under these conditions power could be supplied at a cost very much less than they could ever expect to secure it otherwise; and at the same time an additional demand for power could be created from sources heretofore incapable of being reached.

The report of the Secretary-Treasurer showed a standing membership of 306 with a gain since last year of 39, and a good balance to the credit of the Association.

The report of the Committee to Confer with the Board of Fire Underwriters recommended the advisability of having an Inspector for electric wiring, but a division into two classes should be made, that relating to outside wiring on and over the roofs of public buildings, and that done inside of buildings.

While a visit was being paid to the car-sheds of the Quebec Railway L. & P. Company, Mr. A. B. Lambe, of Toronto, presented a paper on "The Electrical Equipment of an Ordinary Street Car," in which he went very fully into all the details of the equipment. While this paper was somewhat elementary in its character, yet it proved to be very interesting, especially to those who were not familiar with electric street car equipment. By courtesy of the railway, Mr. Lambe had on the platform the necessary working apparatus to illustrate his remarks.

On Friday the election of officers took place and the following were elected: President, B. F. Reesor, Lindsay; first vice-president, Edw. Slade, Quebec; second vice-president, K. B. Thornton, Montreal; secretary-treasurer (re-elected), C. H. Mortimer, Toronto; executive committee: Messrs. J. J. Wright, A. A. Dion, John Yule, O. Higman, A. Sangster, P. G. Gossler, E. A. Evans, A. B. Smith, A. A. Wright and G. Henderson. The convention adjourned; will meet in the city of Toronto in 1903.

Two papers were presented on arc lighting. One of these is entitled "Relative Merits of Open and Closed Arc Lights for Street Illumination," and is the same paper that during the past year or more has been presented by the author, Mr. W. D'A. Ryan, before several electric light meetings. The paper by Mr. Green, entitled "Arc Lighting," is mainly an argument in favor of the enclosed arc lamp. The conclusions of the writer are that the enclosed arc is better and cheaper to operate than the open arc; that the direct, constant-current, enclosed arc system is best and most economical for plants devoted exclusively to arc lighting; and that the alternating, contant-current, enclosed arc system is best and most economical for plants which use large alternators of from 40 to 125 cycles, the arc lighting alone being but a small part of the total output of the system. It is admitted, however, that direct and alternating-current arc lamps are very extensively used on constant-potential systems of distribution for inside lighting, and somewhat

for street lighting, but only when there are special reasons for so doing. Mr. Green considers that the open-coil arc generator of the Brush type is superior to arc generators with closed coil armature for the reason that the voltage at the terminals of the generators on breaking the circuit will not rise over 20 per cent. above the maximum voltage which the machine will supply at normal current, which is not the case with machines of the closed-coil type, in which the rise of voltage is much greater. Another advantage is the great reduction in the number of commutator segments in comparison with generators of the closed-coil type. The advantages of the Brush multi-circuit machines are also set forth. In the opening paragraph of the paper, Mr. Green states that the arc light was discovered by Davy, in 1802, and that it practically remained in the laboratory until the time when Brush began his work. While Davy was first to produce the arc on a large scale, owing to his laboratory coming into possession of, perhaps, the largest primary battery ever made, the electric arc on a smaller scale had previously been obtained and described. The statement as to the electrical arc remaining in the laboratory until Brush invented his type of dynamo ignores the lighthouse plants established during the 60s, using the "Alliance machine," as well as the lighting, by Jablochkoff, in Paris.

In answer to a question by Mr. Lambe, as to what the power factor of the arc was in an ordinary 60-cycle alternating arc, Mr. Green said that one of the writers had given the power-factor of the arc operating from as ranging from one down to six-tenths; he said it depended very largely upon the grade of carbons which were used; very hard carbons lowered the power-factor, conducted the heat away and made the resistance vary greatly, while soft carbons conducted the heat away less rapidly and did not make the resistance change so rapidly. In reply as to whether when the power-factor is less than unity there is a reactance, Mr. Green replied that there is a variable resistance which will give a different power factor from unity; that is, the resistances vary with your current. In answer to a question by Mr. Martin, of Hamilton, as to the candle power of the alternating arc as compared with the direct current arc, Mr. Green said the candle power from the alternating arc was slightly less than from the direct current arc. There is about five per cent difference in candle power between a 450-watt alternating and a direct-current arc.

Mr. F. H. Leonard, Jr., said, that while he did not wish to lead up to an endless discussion, yet he did not like to have the convention left with the impression that there is too much altogether in favor of the direct-current arc system. He was personally very much in favor of the simplest and most uniform system that could possibly be arranged for central station purposes, and for that reason he had, as far as possible in installations with which he had been connected, adopted the alternating current. The advantages of having a single machine which operated all classes of service, it seemed to him, outweighed so much any little advantages that could be obtained by a variety of different kinds of machines and were sufficient to warrant the use of, and he believed that the results obtained with alternating current arcs, certainly for street illumination, could not be excelled by the direct-current arc. In reference to a question asked by Mr. Martin as to the difference between a 60 and 125-cycle arc, and to straighten the matter out, he would like to say with the 60-cycle arc the power factor is very much higher than with the 125-cycle arc, and there is very little difference in the illumination. So far as he had been informed, with the 125-cycle arcs a power-factor of about .67 or .68 and sometimes as high as .70 only could be obtained, whereas from .88 to .90 could be obtained with the 60-cycle arcs.

Mr. Percy Thomas read a paper entitled "Lightning Protection and the Static Interrupter," which covers much of the ground covered by a paper read by Mr. Thomas some months ago before the American Institute of Electrical Engineers. The paper describes the Westinghouse static interrupter, and gives instruction as to the location of the same in plants. The static interrupter consists of a condenser in connection with a comparatively small choke coil, the condenser being connected between the line and ground. The line connection is made between the apparatus to be protected and the choke coil. With this arrangement a comparatively small coil may be used, for the condenser by absorbing a large part of the charge which passes the coil, multiplies the choking effect. It is stated to be possible, by increasing the size of the condenser, to get almost any degree of protection. The use of the static interrupter is stated to render harmless the abrupt waves resulting from lightning and similar causes.

Mr. Lambe asked whether in passing over an unusually high hill it is desirable to have some protector, to which Mr. Thomas replied that that would depend upon how severe the conditions are; if the apparatus placed at the end would not protect, possibly it would be better to have something over the hill. Mr. Lambe also inquired what protection is necessary in taking a secondary system around a town, where a 2000-volt primary ends here, there and all over; Mr. Thomas said that this was a case where actual experience with the plant, if it be an old plant, would have a good deal to do. He thought arresters ought to be placed from three or four to the mile, to one or two to the mile near the greatest number of transformers, and if there were any on the line they should be placed on the end of the line; there would be a reflecting point, and the increased potential would be found there and it was a good thing to have an arrester at that point; the idea being that wherever a wave might be started that it should reach the arrester before it passed to any transformer.

Mr. Gossler and Mr. Martin spoke of the excellent protection from lightning afforded by barbed wire, and Mr. Reynolds, of Philadelphia, mentioned the great value of the storage battery in this connection, the lightning discharge being received by the immense surfaces of the lead plates in the battery, which, while it might destroy one cell, did not cut any figure where there was possibly a collection of 300 cells.

Mr. A. A. Dion read a paper on "The Use of Storage Batteries in Electric Distribution Systems," in which he recapitulates the arguments for the use of storage batteries in central station and electric railway service. The several different methods are taken up in turn, namely, direct-current generation and distribution for lighting and power service; direct-current generation and distribution for railway service; alternating-current generation and transmission, and direct-current distribution for railway service; alternating-current generation and transmission, and direct-current distribution for light and power service; and alternating-current generation and distribution for light and power service. In the three latter cases the rotary converter is used to charge the storage battery and to send alternating current into the line when the battery is discharging.

Mr. Dion referred to his very satisfactory experience with a storage battery in the Ottawa station, where it is run in multiple with direct-current generators operating at 250 and 500 volts on a three-wire system. The battery was placed at the center of distribution, about 1½ miles from the station. Owing to bad speed regulation of water-wheels, and of varying load of direct-current motors, including many elevator motors, it had previously been found impossible to obtain satisfactory regulation. Although the battery is operated without a booster or regulating device of any kind, the improvement made in regulation has been such as to silence all complaints and to elicit complimentary remarks from customers.

In the discussion of Mr. Dion's paper, Mr. Martin and others advocated the use of the storage battery for supplying the line with power at any time when the generating plant is out of order; Mr. Martin instanced a case where this had happened in connection with the Hamilton Street Railway; Mr. Reynolds also spoke of its advantages in this connection.

Mr. Ed. A. Evans, of Quebec, read a paper on "Electric Suburban Railways," in which he dealt with the practical operation of electric cars upon and over the same tracks as were used by the steam railway, the electric cars running between the usual steam railway service. This innovation had been successfully made, and the results, he said, had more than justified the expenditure, in connection with what was formerly the Quebec, Montmorency and Charlevoix Railway, a steam line 30 miles long, running between the city of Quebec and Ste. Anne De Beaupre and Ste. Joachim, now under the control of the Quebec Light and Power Company.

Trolley Refuse Carts.

A new scheme for disposing of the refuse of Brooklyn is being looked into. The plan, which has been devised by H. Milton Kennedy, of the Brooklyn Rapid Transit Company, is to make use of trolley cars in carrying off the refuse, the Brooklyn Rapid Transit Company to take the contract for the work. Mr. Kennedy's idea is to have receiving stations in central parts of the borough. The city's trucks and carts, instead of taking the refuse to the dumps, are to carry it to the stations. The company is to take the refuse on specially constructed flat cars to Flatlands and Gravesend, where it is to be used for filling in land. The belief is that expense can be saved by the plan.

Nineteenth Annual Convention of the American Institute of Electrical Engineers.

THE nineteenth annual convention of the American Institute of Electrical Engineers was held this week at the Berkshire Inn, Great Barrington, Mass., with great eclat and success. As the business sessions last from Wednesday to Saturday, the meeting is still in progress when the current issue of ELECTRICAL WORLD AND ENGINEER goes to press. The attendance was excellent, about 150 being registered by Wednesday noon, with hourly arrivals from different parts of the country until Thursday, totalling over 200.

The convention began with a reception to the Institute in the assembly hall of the Berkshire Inn, at 8:30 on Tuesday evening, when hundreds of the residents of Great Barrington and vicinity turned out to greet the Institute. The hotel and the hall were gaily decorated, and as two or three hundred ladies were present in full evening dress, the affair was a decidedly brilliant one. About 9 P. M., Mr. William Stanley, as chairman of the local committee, made a brief but most eloquent address of welcome on behalf of the community. He referred to the famous natural beauties of the region, as well as to its immortal associations with American history and literature; and described the population as quiet and pastoral in its nature. None the less, they were proud of their intimate connection with some of the best-known achievements and men in electrical work; and he instanced, in particular, the part borne by Cyrus Field in laying successfully the first submarine cables; and he quoted also the name of the late Franklin Leonard Pope, formerly president of the Institute. He made incidental reference also to the upgrowth of electrical industries in the region, and the interest that members would naturally take in the beginnings of electrical work and manufacture in the region. In giving an outline of the programme, Mr. Stanley extended a hearty and cordial welcome to the Institute, and expressed the sense of the honor done to Great Barrington by the holding of the annual Institute meeting there.

Past-President Martin acknowledged, on behalf of the Institute, the address of welcome, and said that already the members, to whom so many friends from the Berkshires were known, had been made to feel at home by the generous cordiality of their reception.

The regular meetings began on Wednesday morning at 9:30, when President Steinmetz called the members to order in the reception hall. The following papers were then read in the order given, discussion being reserved until the close:

"Method of Compounding Alternating-Current Generators and Motors, Direct-Current Generators, Synchronous Motor Generators and Synchronous Converters," by Mr. F. G. Baum, of Stanford University, Calif.

"Formula for Calculating the E. M. F. at Any Given Point on an Alternating-Current Transmission Line," by Mr. Maurice Le Blanc, of Paris, France.

"The New Generating Plants of the Niagara Falls Power Company," by Mr. Harold W. Buck, of Niagara Falls, N. Y.

"Notes on the Theory of Synchronous Motors, with Special Reference to Surging," by Pres. Charles P. Steinmetz, of Schenectady, N. Y.

"The Predetermination of Alternator Characteristics," by Prof. L. A. Herdt, of Montreal.

Discussion was opened by Dr. Perrine, who read an additional and explanatory letter from Prof. Baum, and then passed on to the paper by Mr. Buck, on the Niagara plant, describing the three new 10,000-hp, 12,000-volt, three-phase generators being put in the Canadian power-house. He noted that no efficiencies were given, and also agreed in general with the limitation of the modern tendency to adopt bench-board control of switchboards. It was not the best thing in very large plants. He also expressed a strong opinion in favor of centralizing recording apparatus in the superintendent's office and leaving the switchboard attendant with as few indicating instruments to watch as possible.

As to change from external to internal field, that was certainly radical, but large machines were running already with internal fields, and the change in this case seemed a distinct mechanical improvement.

Mr. Buck described the arrangements for balancing the shaft hydraulically, in the familiar fashion, also the plan of oiling the shaft bearings. The new turbines adopted with ring gate governed from above were of a type not perhaps known in America, but already used in Italy and other parts of Europe. The discussion was participated in by Messrs. Perrine, Buck, Pattison, Garratt and others.

On being urged by Pres. Steinmetz, Mr. Buck gave a few details in regard to the proposed transmission line from Niagara to Toronto, using the current from the 12,000-volt, 10,000-hp machines. He drew a diagrammatic sketch of the transformer, showing how with the five equal windings steps from 11-12,000 up to 40,000 and 60,000 volts would be obtained, getting the full copper efficiency in all the voltages. He also sketched the horizontal porcelain insulator to be used, with five ears and four recesses, and said they were experimenting with sizes from 14 inches down to 8. This insulator has the wire at the center and at a place of minimum liability to puncture of the porcelain, on account of the length of the path.

After this a desultory discussion followed, by Messrs. Kennelly, Adams, Esty, Perrine, Guttman and Steinmetz, on points connected with the Le Blanc, Baum and Steinmetz contributions. The meeting adjourned at 1 P. M.

Abstracts of Papers.

NEW METHOD OF COMPOUNDING GENERATORS AND MOTORS.

Prof. F. G. Baum read a paper giving a method of compounding alternating-current generators and motors, direct-current generators, synchronous motor generators and synchronous converters. The compensating system is shown in Fig. 1. *G* is the generator shown as a two-pole machine. From its shaft is driven the armature, *aa'* having field-poles *AA'*. The armature winding is shown as a single turn of wire, one end of which goes to a solid ring and the other end to a ring broken as shown, the two parts of the latter, however, being metallically connected. It will be noticed that there is no commutation, the same armature wire being always conneted to the same brush. The brush on the broken ring is at the center of one pole, the metallic segments of this ring covering about 90 electrical degrees.

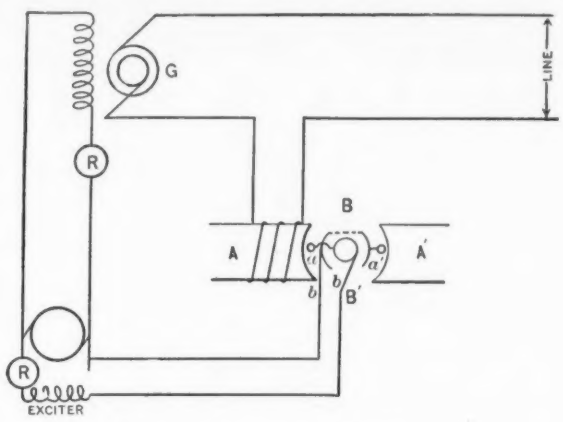


FIG. 1.—COMPENSATING SYSTEM.

If the field *AA'* were excited by direct current, parts of an alternating wave would be obtained at the brush, a part of each wave being cut out owing to the fact that the ring is divided. If *AA'* is excited by a sinusoidal alternating current in synchronism with the rotation of the armature, *aa'*, waves of the e.m.f. are obtained at the brush of different forms depending on the position of the armature coil when the current passes through its maximum value. For example, if the armature coil passes the position shown when the current in the field coil is a maximum, it will be evident that there is a rectified potential at the brushes *bb*. The top of the waves is really cut off, and a potential given at *bb* which may be measured by an ordinary direct-current voltmeter. If the current in the field passes through zero when the armature coil passes the position shown, there is no rectified potential.

The arrangement recommended for practice is shown diagrammatically in Fig. 2, and its application in Fig. 3. The rectified potential is used to excite a small direct-current generator of 100 to 500 watts capacity, and the armature of this machine is connected in series with the series winding on the exciter. The direct current is large, so that only a few turns are needed on the exciter. These may be easily threaded on by hand, if there is not already a series winding on the exciter, so that no new exciter is needed. The percentage compounding may be changed simply by turning the rheostat handle in the armature circuit of the compensator. The compensator has four poles and is

driven in synchronism by a gearing on the generator shaft. The compensator set being small, it is a simple matter to add the compensator to any generator.

This method may be applied to compounding alternators operating in parallel, whether the generators have separate exciters or are all excited from the same exciter. When there is a separate exciter for each machine, the compensator may be applied to each generator, or a

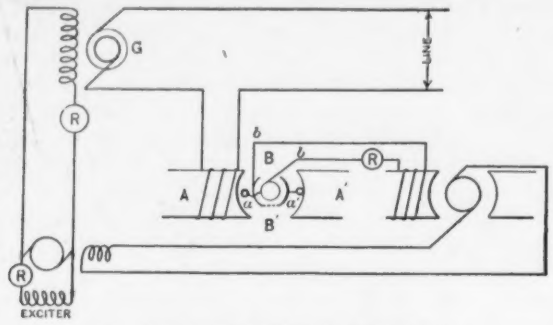


FIG. 2.—COMPENSATOR CONNECTIONS.

single compensator may be put on one generator and the current from the direct-current side carried around each exciter field. The station would then, of course, be compounded only when the generator to which the compensator was connected were running. The entire station may be compounded by a single compensator set where all generators are excited from the same exciter. In this case, the current for the field of compensator would be taken from the bus-bars. Since only a fraction of the exciting energy of the exciter is supplied the compensator set of 500 watts capacity is large enough to compound a 10,000-kw station.

Some of the advantages of this method of compounding are that the generators have but a single winding; no collector bus-bars, switches, etc., are necessary; no adjustment of low resistance shunts

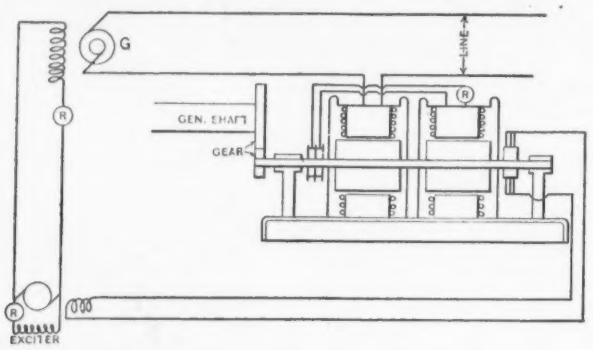


FIG. 3.—GENERAL ARRANGEMENT OF COMPENSATOR.

are necessary to make machines take their proper share of load; when the generators are over-compounded there is no drop in voltage when the brush machine is added. The amount of compounding may be changed instantly by turning a rheostat handle; the cost of compounding a large station will be less than compounding the same number of direct-current generators; owing to the absence of equalizer switches the operation of the station is simpler.

The application of the method is given to compounding synchronous motors, direct-current generators, synchronous motor-generators and rotary converters. Its application is also given to the most general case of the transmission system with a long trunk line having several branch lines. In this case the generators are to be compounded for the center of distribution, and the synchronous motors on each branch line also compounded with respect to the center of distribution.

CALCULATION OF E.M.F. OF TRANSMISSION LINE.

Mr. Maurice LeBlanc communicated a paper giving a formula for calculating the e.m.f. at any point of an alternating-current transmission line. The paper, which is highly mathematical, shows the application of the formula deduced when the line is operated at no load and when the line is rather long. The maximum value which the voltage will attain on a line will occur when the length of the line is equal to ¼ of the length of the transmitted wave. This condition will not generally occur with currents of average frequency but it may occur on long lines with low harmonics and give rise to dangerous surgings in the voltage of the line. Consequently the production of harmonics by the generating and receiving apparatus should be avoided with the utmost care, and in long-distance transmissions the frequency should be as low as possible in order that the length of the line may be always very short in comparison with the length of the waves transmitted.

THE NEW NIAGARA PLANTS.

Perhaps the paper of most general interest on the programme was that of Mr. H. W. Buck, entitled "The New Generating Plants of the Niagara Falls Power Company." A reprint in full of this paper will appear in these columns.

The paper first considers the additions to the present Niagara plant, consisting of eleven 5,000-hp machines of two types. The new turbines, while of the same general type as those in the older power-house, differ in that they are of the internal discharge type and are provided with draft tubes, which add 10 per cent. to the effective head. The remaining capacity of the Niagara tunnel being 50,000, the increase due to this better utilization of the water power permits of the use of eleven instead of ten units. Six of the generators are of the external revolving field type, used in the older power-house, but are designed for a much closer regulation—10 per cent. instead of 30 per cent.—the collector rings, moreover, are placed at the bottom instead of at the top of the dynamo shaft, and centrifugal ventilation is employed.

The five other generators are of the internal revolving field type, being thus similar to the standard type of alternator. All generators will have a speed of 250 r. p. m., and generate current at 2,300 volts and 25 cycles. The efficiency of the external field generators was found by test to be 98.15 per cent.

The exciter plant is located at the bottom instead of the head of the pit, being installed in a recess and driven by a vertical turbine. Many changes have been made in the switching arrangements, there being only one board instead of two, as in the older power-house. Electrically-operated oil-break switches are employed, and switching is done by means of relay switches placed in such a relation to imitation bus-bars that the connections are clearly indicated—the real switches being on the power-house floor. Mr. Buck criticizes unfavorably the system of bench-board switch control.

Instead of the ordinary time-limit relay, a device is used, consisting of a dash-pot attachment to the tripping plunger of the dash-pot. This retards the movement of the plunger for ordinary temporary overloads, but if a real short circuit occurs, the pull on the plunger is so strong that the dash-pot has no effect.

It is the intention to operate the 21 generators normally in four independent groups, but the arrangement of circuits is such that they may all be operated in parallel, or any one generator thrown on any group.

The paper also describes briefly the main features of the great plant to be erected on the Canadian side of the Falls, with an ultimate capacity of several hundred thousand horse-power. The units will be similar to the new Niagara design, above-referred to, and of 10,000-hp each. They will be wound for 12,000 volts, three-phase and 25 cycles, at 250 r. p. m. The weight of the revolving part will be 141,000 lbs, and the diameter over-all only 19 feet—the machines taking little more space than one of the older 5,000-hp units. For long-distance transmission the voltage will be stepped-up to 22,000, 40,000 and 60,000 volts, respectively—the latter to be the Toronto transmission voltage. The hydraulic features of the plant will be similar to the American plants.

THEORY OF THE SYNCHRONOUS MOTOR.

With the title, "Notes on the Theory of the Synchronous Motor," President Steinmetz presented the first section of a contribution to the mathematical theory of this type of motor. It is pointed out that synchronous motors—including the rotary converter—unlike induction motors, can at the same power output have the voltage, current, power-factor, etc., varied over a wide range by varying the field excitation—that is, the counter or "nominal" induced e. m. f. As a consequence, this type of motor can be utilized to a considerable extent to control the phase relation, and thereby the voltage, while at the same time producing mechanical power.

The paper proceeds to develop the mathematical theory of the motor, both graphically and analytically, numerical examples being solved to illustrate the application of the results arrived at. It is shown that a given impressed voltage and current output, the power output of the synchronous motor, can vary over a wide range, and also that for each value of power output there corresponds a lagging

and a leading current. As excitation is increased the lag of current is decreased until it becomes in phase with the e. m. f.; and if further increased the current leads the e. m. f.

The second portion of the paper deals with the case of a motor not having constant speed, as when it is accelerated or retarded from any cause. This phenomenon of surging is denominated electro-mechanical resonance, and is made the subject of mathematical analysis. The result shows that the frequency of oscillation does not vary much with the load and with the excitation, and that it slightly decreases with increase of load, and increases with increase of excitation.

The third section of the paper treats of the theory of damping devices, and the final section considers means for avoiding surging. An external cause of surging may be the field of a self-exciting, direct-current generator, driven by the synchronous motor, and if the generator is also the exciter of the motor, the effect may be intensified. The governor of the prime mover may also act to cause surging. Internal cause may be found in the lag of the synchronous motor field behind the m. m. f.. Appliances, such as short circuits around the field poles, while increasing the steadiness of a steady motor, will increase the unsteadiness of an unsteady motor.

The final conclusions are that the avoidance of surging requires consideration; first, of the design of the motor and the system on which it is to operate; second, the use of anti-surging devices, such as an induction motor winding in the field poles or short circuits between or around the poles; third a flexible connection, such as to a flywheel or by a belt to the load.

DETERMINATION OF ALTERNATOR CHARACTERISTICS.

With this title, Prof. L. A. Herdt read a long paper on indirect methods for the determination of the characteristics of alternating current apparatus. The subject is treated under the following heads: Armature reaction and armature reactance, tests of an inductor alternator, alternator regulation and indirect methods for determination, application to inductor machine, application to other types.

Complete numerical and graphical data are given from a test of 15.4-kw, 110-volt inductor alternator, at a speed of 720 r. p. m. For determining alternator regulation three methods are described, namely, the short-circuit characteristic method, the "composing m. m. f." method and the "two reactance" method, all of which were applied in testing several machines. In the case of the inductor alternator above mentioned, the short-circuit method gave a better result than the "composing e. m. f." method, but the "two reactance" method gave the best result, and in other tests the latter method gave the most correct results.

SINGLE-PHASE ALTERNATORS IN POLYPHASE CIRCUITS.

Mr. C. O. Mailloux presented a paper giving an account of an interesting experiment with single-phase alternators connected to a polyphase circuit. The paper was prefaced with an account of the plant of the Phœnix (Arizona) Light and Fuel Company, where the experiment was tried. The plant will have two water-power stations located about 15 miles apart, generating three-phase currents at 22,500 volts and 60 cycles. The receiving station will be situated 9 miles and 24 miles respectively from the generating stations, which latter will have an aggregate capacity of 600 kw. At present one of the water-power stations is in operation, and also a single-phase monocyclic steam station in Phœnix, which will later be discarded and the site used for a receiving station.

In order to tide over until the second generating station is completed, it was desired to run the single-phase steam plant in connection with the polyphase water-power plant, and to this end the following experiment was made:

Arrangements were made for coupling the single-phase alternators, each with one phase of the two-phase bus-bars in the sub-station. The necessary connections having been made, and a Lincoln synchronizer having been procured and connected, the experiment of coupling first one, then another of the alternators in multiple with either of the two phases was tried, the alternator being brought to the synchronous speed by regulating the engine throttle-valve. The next step was to connect one of the alternators with each phase. This was done easily. There was no difficulty in making the alternators keep in step and in making them carry a proportion of the total load. It was also found, as was to be expected, that the alternators would be utilized in balancing the two phases, in case they were unequal in potential difference, owing to unequal loads.

The next step was to determine if two single-phase alternators could be maintained in two-phase relation by means of a rotary converter, when they were the sole source of the energy conveyed to the entire system. After careful consideration of all the reactions involved, the experiment was decided upon. The results completely justified the confidence with which the experiment was tried.

The generators having been connected with the transformers and excited so as to give the full line voltage on the transmission line, the rotary converter was then started in the regular way. This having been done, two of the single-phase alternators were then coupled in succession to the feeder bus-bars, one to each phase. In coupling each alternator, a Lincoln synchronizer, suitably connected was used as a phase indicating device. After the two alternators had been coupled, each to one phase, the connections of the Lincoln synchronizer were then changed so as to show the phase relation between the two phases of the lighting feeder bus bars. The instrument showed that a perfect quarter-phase relation was being maintained between the two phases, as was expected. The load on each machine could be adjusted, both by regulating the steam supplied to the engine at the throttle-valve, and by changing the excitation of the magnetic field.

After all adjustments had been completed, the line switches were then quickly pulled open, thereby disconnecting the transmission line, and shutting off all electric energy supplied from the water-power station. At the instant of disconnecting the speed of the rotary converter fell off slightly, as was evident not only by the frequency pitch or tone, but also by the readings of the direct and alternating voltmeters. This falling off was ascribed to the fact that the engine throttle valves were not fully open. On opening the throttle, the speed rose gradually, until the frequency again became about the same as it was before disconnecting the transmission line. The index of the Lincoln synchronizer remained all the time at a point 90° from the position of synchronism, showing that the two single-phase alternators were being kept perfectly in the same two-phase relation as when the rotary converter was run with current supplied from the transmission line. The external load was then varied by opening and closing the feeder-line switches at the lighting switchboard. The maximum load put on was equivalent to more than three-quarters of the full current capacity of each alternator; the load being composed almost entirely of incandescent lights, the power factor was, of course, somewhat high.

After continuing the experiment for about ten minutes the alternating current-switches of the rotary converter were opened and the single-phase alternators immediately disconnected, the synchronizer having shown that the quarter-phase relation was lost at the same instant that the rotary converter was disconnected. The experiment was repeated with slight variations two or three times, and each time with perfect success. It was found that by opening the engine throttles somewhat more than was done in the first experiment, and increasing the steam pressure available at the engine cylinder before disconnecting the transmission line, there was less falling off of the frequency at the instant of disconnecting. It was observed that the alternating current in the rotary converter increased slightly, as was to be expected at the time of disconnecting the transmission line. This was of course, due to the new inter-reactions taking place between the single-phase alternators and the rotary converter in consequence of the new function imposed upon the converter, that of acting as an electromagnetic coupling and flywheel for the two single-phase alternators. It was found that the amount of this current could be varied, to some extent, as was to be expected, by varying the field strength of the rotary converter. There were no facilities for imposing a direct-current load on the rotary converter in addition to the load resulting from its operation as a phasing device for the two alternators. There is no reason to doubt, however, that a direct-current load could have been placed upon the rotary converter up to the full generating capacity of the two single-phase alternators serving as the source of current supply in the experiment. The experiment may, therefore, be taken to be a sufficient demonstration of the possibility of using single-phase alternators to produce two-phase current, three-phase current and direct current, with an arrangement and under conditions such as shown in the diagram.

The paper proceeds to discuss at length the reactions that take place in operation under the above conditions. It is concluded that the synchronizing force comes from the phase connected with the leading alternator, to the phase connected with the lagging one, the converter being an elastic coupling medium.

ELECTRIC TRACTION FOR THE NEW YORK CENTRAL RAILROAD.

Without doubt the most important practicial paper read was that of Mr. B. J. Arnold, entitled "Method of Ascertaining by Means of a Dynamometer Car the Power Required to Operate the Trains of the New York Central and Hudson River Railroad Between Mott Haven Junction and Grand Central Station, and the Relative Cost of Operation by Steam and Electricity." The paper, in fact, is an abstract of the report made by Mr. Arnold to the New York Central authorities, in which a plan is proposed for handling the urban part of the system by electric power.

Details of the tests made are given, accompanied by tabulations and many curves. Calculations showed that the electrical energy required to haul a ton one mile over the division of the road over which the tests were made would be 63 watt-hours per ton-mile.

As a result of the investigation, Mr. Arnold recommended the direct-current system in combination with the third rail for the main line, and overhead construction for the yards. All of these elements have demonstrated fully their ability to meet the conditions imposed by railway operation so far as motive power is concerned, although there has not yet been an electric installation on any existing terminal that is as complex, or into which anywhere near the number of heavy trains enter as on this section of road.

Had the length of road under consideration been considerably greater, and had it been thought possible to secure sufficient time to conduct experiments or invite demonstrations by manufacturers of alternating-current motor equipment, this class of apparatus would have been more seriously considered.

In the preparation of estimates, 12 distinct plans of generation and distribution were considered. All the estimates were computed upon the same basis so far as cost of fuel, labor and losses in transmission were concerned. The plan, which a careful study showed to be preferable, involves a combined direct and alternating-current power station at Harlem, run near one end of line, with a rotary converter substation near the other end of the line, the transmission being at 11,000 volts, and the distribution at 600 volts, direct. One storage plant is provided in or near the powerhouse, and another at the substation, each of such capacity it may, together with only a portion of the main station and substation machinery, take care of the entire load of the line for a short period in case of emergency.

The following figures are given as to the comparative cost of the steam and electric systems:

	Steam.	*Electricity.*
Operating expenses per locomotive mile exclusive of fixed charges but including water, labor, cost of cleaning and repairing tunnel, and all other expenses of locomotive operation	23.05	15.80
Fixed charges per locomotive mile, assuming that it now requires 40 locomotives to perform the present service, and that 33 electric locomotives could perform the same service	1.13	7.83
Total in cents	24.18	23.63

From these figures it appears that while there would be a slight annual saving in operating expenses in favor of electricity, it is not sufficient to warrant its adoption on the grounds of economy in operation alone, although its adoption can be justified on other grounds.

These figures could be made more favorable to electricity were an optimistic view of many of its advantages taken, and the probability is that practical operation will show a somewhat greater gain than here indicated, but Mr. Arnold deemed best a conservative view throughout the entire investigation. It is, however, safe to conclude that the saving in operation expenses by the electric system would be sufficient to offset the increased fixed charge due to the additional investment made necessary by its choice.

COMPARATIVE ACCELERATION TESTS WITH STEAM LOCOMOTIVE AND ELECTRIC CARS.

A joint paper, by B. J. Arnold and W. B. Potter, with the above title gave an account of experiments carried on by means of a dynamometer car ,to determine data for a comparison of steam and electric traction on short-haul suburban passenger service. The tests were made with a steam locomotive, designed specially for the rapid acceleration work required in suburban service, and with two 35-ton electric motor cars, adaptable to similar service. A train of six cars, including five New York Central passenger coaches, and the dynamometer car, was started and run over a mile of track, acceleration being made as rapidly as possible; on some of the runs the train was hauled by the locomotive, and on others by the motor cars. Full data of the tests are tabulated, including weights, speeds, watt-hours per ton-mile, etc., and acceleration, speed, torque and other curves plotted from the data.

The data bring out clearly the fact that the electric motors during acceleration can utilize the weight on the drivers more effectively than the locomotives. Owing to motors being able to maintain their maximum accelerating rate longer than the locomotives, they were able to cover the same distance in the same time with less energy expended and at less maximum speed. With a shorter run, the motor cars were able to make higher average speeds than the locomotive over its longer distance, and these higher speeds were also obtained with a lesser maximum speed.

On the basis of the energy per seat mile, the weight of the steam locomotive capable of performing the same service is considerably greater. For example, with six cars to a train, the watt-hours per passenger would be 43.9 with steam, and 29.7 with electricity, which figures become 187.8 and 45.2, respectively, for one car.

The paper gives the efficiency of an electrical system between boiler and track as 51.33 per cent., based upon the following component efficiencies: Engine, 90 per cent.; alternator, 92 per cent.; high potential transmission, 98 per cent.; transformers, 97 per cent.; converters, 92 per cent.; third rail, 95 per cent.; motors, including control, 75 per cent..

In the case of the locomotive, the coal per effective hp per hour is calculated to be 15.6 pounds. Assuming a consumption of 2½ lbs. per hp-hour at an electrical plant, and 50 per cent. efficiency for the motor, the corresponding figure for electric traction is 5 lbs. of coal. Assuming that the cost of coal for electrical power is one-third of the total cost, including maintenance and interest on investment, it is probable that the actual gross cost of electrical power would closely approximate the coal consumption of a steam locomotive in this class of service, the maintenance of the electrical equipment and attendance required being, however, considerably in favor of electrical power.

THE FUNCTION OF SHUNT AND SERIES RESISTANCES IN LIGHTNING ARRESTERS.

In a paper with this title, Mr. Percy H. Thomas describes a new method of enabling a lightning arrester to suppress an arc which may follow a lightning discharge, which otherwise will maintain a circuit from the station generator. The device involves the use of series and shunt resistances in connection with a multi-gap arrester.

The paper refers to previous work in the use of shunts with lightning arresters, and gives at length the principles involved. A circuit illustrating the shunt principle is shown in Fig. 1. It consists of a number of small air gaps connected between line and ground, a portion of the gaps being shunted by a resistance, as indicated, and a series resistance placed in earth connection. The shunt resistance is usually placed next to the series resistance, as shown, and half the total number of gaps are shunted.

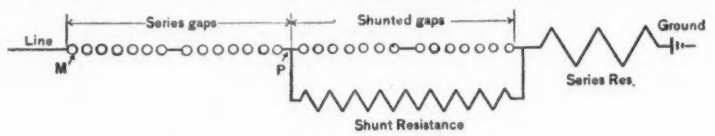


FIG. 1.—ILLUSTRATING SHUNT PRINCIPLE.

When the arrester is not in action, the point P at the junction of the shunted and series gaps is at ground potential, and consequently the arrester will discharge whenever the voltage of the point M of the line reaches a potential above the ground sufficient to cause the series gaps to break down; that is, the voltage on the line necessary to cause the arrester to discharge, is that required to break down the series gaps alone, regardless of the presence of the shunted gaps. During actual discharge the series gaps break down, and the resistance between the points M and P is momentarily reduced to practically zero, and the full amount of the potential of the line is then thrown on the shunt and series resistances. If this potential, which is thus abruptly applied to the resistances, is high, the shunted gaps

will be broken down. This makes, for the instant, a direct path for the static discharge from line to series resistance. If conditions are right, current from the generator will then follow the static discharge through the gaps, establishing an arc. The current will flow through the shunt and series resistances and usually through the shunted gaps, but if the various parts are properly proportioned, the shunt resistance will take enough current from the shunted gaps so that the arc cannot hold in the latter and will drop out. Once the arc drops out in the shunted gaps, it must pass through both resistances, which will reduce the current strength, and enable the series gaps to suppress it altogether.

The series resistance, though from one standpoint objectionable, is found necessary for the successful operation of the arrester, in order to prevent the enormous rush of current, which, on circuits of large generating capacity, would otherwise follow discharges and cause lights to dip and synchronous apparatus to fall out of step, as well as overheating the arresters themselves.

The paper then proceeds to an explanation of the principles of the multi-gap and alloy cylinders in lightning arresters, which subject is considered under the heads of generator voltage, short-circuit current, inductance, frequency and phase of e. m. f. at time of discharge. The considerations governing the choice of shunt resistances are then given, and the paper concluded with sections on the design of an arrester, and a method of experimenting with the same.

THE ELECTROSTATIC WATTMETER IN COMMERCIAL MEASUREMENETS.

Mr. Miles Walker read a paper with the above title, giving the application of the Kelvin quadrant electrometer to electric power measurements. Used as a wattmeter, this instrument reads the power correctly whatever the shape of the wave form, for at any instant the turning moment is proportional to the instantaneous value of the power and the needle takes up a position that corresponds with the average of the instantaneous turning moments. The accuracy of the instrument with low power factors, its wide range and freedom from burning out, make it suitable for general testing purposes, whenever low power factors are likely to be met with. When the power of a three-phase motor is measured in the ordinary way, with two successive readings on a wattmeter, one of these readings will be negative, or of very low power factor, when the motor is lightly loaded. It may be necessary to take the difference between two readings, both of which are inaccurate on account of the effect of the low power factor upon an ordinary wattmeter, and the final results will be very far indeed from accurate. On the other hand, an electrostatic wattmeter can be made to read power supplied at pressures as low as 100 volts.

The paper deduces the equations applying to this use of the quadrant electrometer, and gives instructions for connecting up in different cases.

Notes of the Institute Convention.

THE SPECIAL TRAIN from New York left at 2 P. M., on Tuesday, and reached Great Barrington at 5:30, with nearly 75 members and friends on board. The trip was made in delightful weather, and the Berkshires never appeared more cool and beautiful than to the senses of city folk who had just undergone the worst weather of the season, in heat and humidity.

MR. STEPHEN D. FIELD came over from Stockbridge, and was heartily greeted by a host of friends who had not seen him since his return from Geneva, Switzerland, where he has been busily engaged during the past four years constructing street railway systems.

THE TOWN HALL was the scene, on Thursday evening, of a notable assembly and ball, where all the youth and beauty of Berkshire was focussed to do honor to the visitors. Outside hung a fine sign with the badge of the Institute executed in colored incandescent lamps. Inside the lighting was equally profuse, and was supplemented by floral work. In fact, some 2,000 lamps, all told, are said to have been used for the lighting, while everywhere the eye rested on green foliage and bright flowers. Dancing was kept up to a record hour for Great Barrington, and some of the members, still in evening dress, were ready to help President Steinmetz open the regular proceedings at 9 A. M., on Friday.

THE STANLEY COMPANY was naturally very much in evidence durthe week, and the recent deals connected with its control and management formed a frequent theme of conversation. It was generally understood that a further step likely is the acquisition of the Ganz rights and details for this country.

FRIDAY AFTERNOON was reserved for a visit to the factories of the Stanley Electric Manufacturing Company, for trips by trolley around Pittsfield and Dalton, and for a garden party at the residence of Dr. F. A. C. Perrine, where Mrs. Perrine was to be assisted in receiving by representatives of the Institute. Our report had closed, however, before these events came off.

THE PROGRAMME of papers given in these pages was duly carried out, all the papers on electric railway work being presented on Thursday, as listed. The discussion was opened in his usual brilliant and incisive manner by Mr. Sprague, who received quite an ovation. Mr. F. S. Pearson, as a leading operator of electric railway systems, was also very heartily greeted by the members. One of the most striking features of the whole session was Mr. B. J. Arnold's brief presentation of his plan for calling in the aid of compressed air for heavy electric traction. Briefly stated, the plan consists in a combination of electrical power and compressed air. The energy that is always wasted in overcoming resistances in stopping or starting motor cars he employs in compressing air, and thus storing away power for use when needed. This air power is utilized either as an auxiliary to the motor in procuring high bursts of speed or as a brake, or as a substitute for the electric power should the motor be deprived of current at any time. Mr. Arnold has built and operated, for his own experiments, a 20-mile track, on which he has tested all his devices. In his address, after expressing his belief in the efficiency of alternating currents as opposed to direct, the engineer thus sums up the results which he believes he has attaned: First—the entire elimination of the present standard system of rotary converter substation plant, together with the maintenance thereon and the cost of the necessary attendants. Second—A large reduction in the first cost of electrically equipping long-distance railroads, thereby making it feasible, from an engineering and business standpoint, to equip many roads on which it cannot now be shown to be advisable.

AN ORGAN RECITAL in honor of the Institute was given on Thursday afternoon, at Barrington House, the palatial residence of Mr. Edward F. Searles, said to possess the finest private music chamber in America. It contains a large pipe organ, designed and built by Mr. Searles himself, and the distinguished organist, Mr. Henry Rowe Shelley, arrived from New York to give a programme that illustrated its remarkable range of power, tone color and sensitiveness of control. The visitors were received by Mr. Harry Douglas, curator, and Mr. Searles himself, and after the organ recital, the art treasures of the place were thrown open for inspection. In the evening Mr. Searles entertained a few of the prominent members of the Institute, and gave them a further musical treat. He also showed them what is one of the very earliest private lighting installations in the United States, as well as a few more of the artistic curios he has gathered the world over. After a couple of memorable hours, the party toasted their host as a "kindred spirit" and thanked him in the Institute's name for the exquisite courtesy shown upon the occasion of its visit to Great Barrington.

LECTURE EVENING.—The evening of Wednesday was devoted to the exhibition of a large number of lantern slides on subjects of an electrical nature, and treated popularly for the benefit of the public of Great Barrington. The meeting was held in the Town Hall, which was crowded with an audience of 700 or 800 people, many of whom had driven in from the surrounding farms and country homes. The speakers were introduced by Secretary Pope, and the proceedings were interspersed with music. The first item on the programme was a series of slides presented by Mr. T. C. Martin, illustrative of the decorative use of the electric light, and based very largely upon the work done by Mr. Luther Stieringer at successive expositions, including Chicago, Omaha, Atlanta, Buffalo Pan-American. Paris, in 1889 and 1900, was also illustrated as exemplifying foreign work. Mr. Martin showed how electric lighting, and particularly the incandescent lamp, had lent itself to this work, and pointed out how large a part electricity could play in adding to our æsthetic and intellectual pleasures, as well as in subserving utilitarian needs. Some 50 beautiful slides were exhibited, supplemented by request with some from the collection of Chairman Calvin W. Rice, and including portraits of Kelvin, Steinmetz, Edison, Elihu Thomson and W. Stanley, whose first transformer and first alternating-current pole line erected in Great Barrington, were also shown. Mr. W. B. Spellmire, of the Bullock Company, in behalf of Mr. R. T. Lozier, then presented a series of slides devoted to the special uses of electricity, beginning with the historic

Sprague road, at Richmond, and closing with the Baker torpedo automobile, which had made a speed of 90 miles an hour before destroying itself. The series included, also, views of machinery driven by motors and of the factory at Niagara, where crackers are baked by electricity, and where, in the restaurant, little electric cars bring to each guest the items ordered from the menu. Next came Dr. F. A. C. Perrine, president of the Stanley Electric Manufacturing Company, who showed a wonderfully fine series of slides, illustrative of some of the engineering feats done in California, especially those required in installing the 220-mile line and the plant for sending power from the Sierra Nevadas to San Francisco. The last item on the programme was presented by Mr. W. J. Jenks, of the legal and standardizing bureau, who submitted and described a unique series of slides of lightning flashes and forms of all classes. This closed a solid three hours of varied entertainment, traversing the whole art of electricity in pictorial fashion, and which if applause be any criterion, was hugely enjoyed.

A MOST ARTISTIC BOOKLET was that which had been prepared by the Local Committee, and which had been printed by the Griffith Press, of Holyoke. It was in oblong form, 12 inches by 6, enclosed in a gray paper wrapper, stamped with the badge of the Institute in gold. The cover of the programme was in deep shades of blue, green and gold, with title, seal of the Institute, etc., in green and gold, and inside were 20 pages devoted to giving information, with the names of the local committees, the programme, views of the surrounding country, and snatches of verse, by such local but national poets as William Cullen Bryant—the Berkshire Inn, by the way, standing where stood the Bryant house, now moved back a little from the road. The demand for these handsome souvenirs was so keen that a large edition was early exhausted, and more are being printed.

THE STANLEY LAWN PARTY, at near Mr. Wm. Stanley's new home, "Brookside," on Wednesday afternoon, was one of the most delightful affairs and decided successes of the whole week. It was attended by several hundred people, who gathered around the tea tables or spread over the lawns and witnessed the evolutions of the May Party of young girls, in yellow and white, or listened to the arcadian comedy in the little theatre under the trees. The lakes, the grass, the trees and mountains were at the height of their charm, and the lovely scene was one from which it was impossible to withdraw the gaze.

MR. WM. STANLEY, who from his dash and vim, has sometimes been called the Prince Rupert of electricity, never gave stronger evidence of his capacity and enthusiasm than during the whole week, when, aided by Mrs. Stanley, he spared no effort to live up to his responsibilities as chairman of the local committee. While extending a boundless hospitality himself, he had also to direct the manifold courtesies of the whole community, and his work was well done.

"No. 8," where the local committee held forth, soon became an electric club, and members hied thither at all hours of the day and night to enjoy the hospitality of the committee there provided under the care of a butler and the indefatigable members of the committee itself. More good stories with a technical twist were told in "No. 8" than any member of the Institute could ever recall as characteristic of any previous convention. The idea to provide these rooms was a very happy one, and was much appreciated by all.

MR. E. H. MULLIN, who directed transportation and hotel accomodation, had no easy job, for the roster grew bigger and bigger, swamping all available space, and it was conceded on all hands—even by those who could not get a "room with bath," that no one else could possibly have done better. But Mr. Mullin was very glad when Saturday came and he knew that no more unexpected batches of ten or twelve could drop in and besiege him for the best rooms in either hotel—for he ran not only the Berkshire Inn, but the Barrington and the Miller, with sundry cottages thrown in. His General Electric training on large affairs and big diplomacy stood him in good stead.

THE LOCAL COMMITTEE, to whom the credit of the success at Great Barrington must be attributed, were William Stanley, chairman; John H. C. Church, treasurer; Harry Douglas, secretary; Parley A. Russell, Great Barrington; Frank H. Wright, Great Barrington; Frederick N. Deland, Great Barrington; Charles N. Gilbert, Great Barrington; John B. Beebe, Great Barrington; William H. Browne, Great Barrington; F. A. C. Perrine, Pittsfield, Mass.; W. W. Gamwell, Pittsfield, Mass.; John F. Kelly, Pittsfield, Mass.; C. C. Chesney, Pittsfield, Mass.; Daniel England, mayor, Pittsfield, Mass.; Stephen D. Field, Stockbridge; W. C. Dalzell, South Egremont. The committee of the Thursday Morning Club was Mrs. O. W. Lane, Mrs. William Stanley, Mrs. H. C. Joyner, Mrs. Alice Whiting, Mrs. A. C. Collins.

DR. A. E. KENNELLY addressed the Ladies' Thursday Morning Club on Thursday, at Kellogg Hall, on the subject of "Wireless Telegraphy," which he handled in a popular manner with accustomed clearness and grace of diction. He was heard with great delight by a large audience.

Attendants.

Following is a list of those registered at the convention up to Thursday:

W. C. Andrews, Harry Alexander, C. A. Adams, Mr. and Mrs. A. H. Armstrong, W. S. Andrews, B. J. Arnold, Mr. and Mrs. A. E. Averrett, E. H. Anderson.

A. C. Bell, Mr. J. J. and Miss Bellman, Douglass Burnett, R. H. Bell, W. H. Browne, E. G. Bernard, H. W. Buck, Morgan Brooks, G. H. Bragg, C. E. Bibber, H. D. Bayne, H. A. Burson, W. S. Bennett, E. J. Berg, H. W. Bowen, P. A. Bates, C. S. Bradley, A B. Bradley, R. D. Brown.

Chas. L. Clarke, H. M. Cogan, W. R. C. Corson, Wm. Curry, E. E. F. Creighton, C. E. Canfield, Mr. and Mrs. C. C. Chesney, F. B. Crocker, Mr. and Mrs. F. E. Case, J. H. Craig.

Louis Duncan, Edward Durant, Thos. Dempster, Mr. and Mrs. S. T. Dodd.

Miss Ernst, Henry S. Eddy, Horace T. Eddy, J. B. Entz, Mr. and Mrs. W. G. Ely, Jr.

S. D. Field, W. L. Fairchild, C. E. Farrington.

A. A. Gray, Mr. and Mrs. A. V. Garratt, L. Guttman, A. G. Grier, J. M. Gilmore, Mr. and Mrs. W. W. Gamwell, W. E. Goldsborough, E. W. T. Gray.

W. H. Hale, E. W. Hammer, Carl Hering, H. F. Hoxie, C. W. Holtzer, Mr. and Mrs. C. H. Hines, W. E. Haskins, H. E. Heath, E. Heitmann, B. K. Hough. C. F. Hopewell, M. G. Haight, Mr. and Mrs. G. A. Hamilton, Miss Hamilton, Mss Edith Hamilton, A. B. Hendricks, Jr.

Hanford Judson, W. J. Jones, A. P. Jenks, W. McA. Johnson, Mr. and Mrs. W. J. Jenks.

A. E. Kennelly, Mr. and Mrs. J. F. Kelly, August Kruesi, J. D. Keiley.

Miss Ella Levy, Miss Lieb, Mr. and Mrs. C. A. Lieb, Mr. and Mrs. J. W. Lieb, Jr., R. D. Lillibridge, Miss Lillibridge, W. J. Lloyd, F. V. T. Lee, Mr. and Mrs. H. Ward Leonard, Mr. and Mrs. A. B. Lisle, Lamar Lyndon, Mr. and Mrs. Herbert Lloyd, R. W. Lohmann, D. R. Lovejoy.

E. H. and Mrs. Mullin, Miss Michaelis, Mr. and Mrs. T. C. Martin, L. B. Marks, Mr. and Mrs. Wm. Maver, Jr., Mr. and Mrs. T. E. Murray, Mr. and Mrs. C. O. Mailloux, W. L. Mulligan, John Murphy, C. P. Matthews, E. G. Merrick, Miss McIlvaine, G. E. Miller, J. R. McKee.

R. B. Owens.

R. W. Pope, Mr. and Mrs. F. A. Pattison, Mr. and Mrs. J. S. Peck, L. K. Perot, Mr. and Mrs. C. W. Price, Miss Leonice Price, Miss Gray Price, Amy S. Pope, H. C. Parker, Mr. and Mrs. F. A. C. Perrine, G. W. Patterson, Jr., Henry W. Pope, Mr. and Mrs. F. S. Pearson, F. S. W. Pope, C. H. Porter, W. B. Potter, A. L. Pierce.

W. I. Reich, H. D. Reed, Calvin W. Rice, Norman Ross, Miss Clara Russel, E. B. Rosa, H. G. Reist, D. B. Rushmore, W. L. Rugg.

Luther Stieringer, Mr. and Mrs. A. B. See, J. E. Schmidtt, Langdon Smith, Geo. F. Sever, W. B. Spellmire, C. P. Steinmetz, Joseph Sachs, Wm. and Mrs. Stanley, C. E. Skinner, Walter I. Slichter, Jas. H. Styles, W. N. Smith, F. J. Sprague, Oberlin Smith, Samuel Sheldon, G. O. Squier.

Calvert Townley, Mr. and Mrs. P. H. Thomas, A. E. Truesdell, E. J. Thompson, Elihu Thomson, Mr. and Mrs. David P. Todd, H. W. Tobey, Albert Taylor, Miss Dora Truesdell.

F. K. Vreeland, Richard Varley.

J. Wilkinson, Mr. and Mrs. Jos. Wetzler, W. H. Wiley, F. F. Wood, Mr. and Mrs. J. M. Wakeman, C. B. Wismer, Arthur Williams, H. R. Wellman, R. N. Williams, G. W. Whittimore, P. B. Woodworth, Mr. and Mrs. E. J. Willis, W. D. Weaver, J. D. Wright, Miss Isabel M. West, Miss Ara M. West.

Recent Progress in Electrochemistry.

By CLINTON PAUL TOWNSEND.

THE EDISON BATTERY.

In accordance with the practice of the U. S. Patent Office in rigidly excluding from a single application more than one specific form of an invention, the Edison battery, which is not a unitary device, is being protected by a considerable number of patents, substantially identical in their disclosure, but limited in their claims to one or another form of the oxidizable or the depolarizing element. The most recent of these patents deals with a depolarizer of a "specific magnetic metal other than iron"—*i. e.*, nickel or cobalt, in the form of a hydrate, mixed with flake graphite, and compressed in the perforated pockets of the plate. These plates are substantially those heretofore described, comprising frames of nickel or carefully nickel-plated iron, and retaining shells of hard-rolled sheet nickel, .005 inch in thickness, and closely perforated with holes of .015 inch diameter.

The nickel compound is the hydrated lower oxide, prepared by first precipitating either the monoxide or the black hydrated dioxide, filtering and washing and drying the precipitate. The resulting compound is finely powdered, mixed with something over 40 per cent. of its weight of flake graphite, moistened with strong potassium hydroxide, packed into the pockets and electrolytically oxidized to that higher stage believed by Mr. Edison to be represented by the formula $Ni_2 O_3$. The oxidation is practically limited to the surface of contact with the conducting material, and the function of the graphite is to greatly extend this surface.

This depolarizing agent is employed with any one of several oxidizable elements as iron, cadmium or copper. Iron is produced by the electrolytic oxidation and subsequent reduction of the monosulphide, no reference being made to the recently described method of production from scale-oxide. Cadmium is best obtained by electro-deposition from the sulphate solution with high cathode current densities, the metal being precipitated under these conditions in a finely divided state. Copper in suitable form is obtained by reducing the carbonate by hydrogen at the minimum temperature, and subsequently oxidizing it also at low temperature to the black oxide $Cu\ O$, followed by electrolytic reduction to metal. Upon discharge, the iron is oxidized to its ferrous state, the cadmium to its oxide, and the copper to its red oxide $Cu_2 O$. Iron and copper should be admixed with flake graphite, but in the case of cadmium this may be omitted by reason of its superior conductivity. Mr. Edison's claims for his battery are stated as follows:

"My improved battery can be overcharged, fully discharged, or even reversed and charged in the opposite direction without any injury. Overgassing does not disturb the initial state of the materials in the pockets. All the ingredients are insoluble, the supporting plates are unattacked by electrolytic oxidation, and the whole operation is independent of the strength of the solution, so that the battery is of great permanence, while at the same time more energy will be stored per unit of weight than with any other permanent practical combination heretofore suggested."

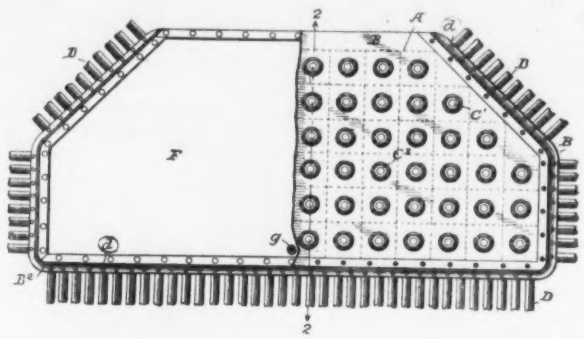
ELECTRIC FURNACE TERMINAL.

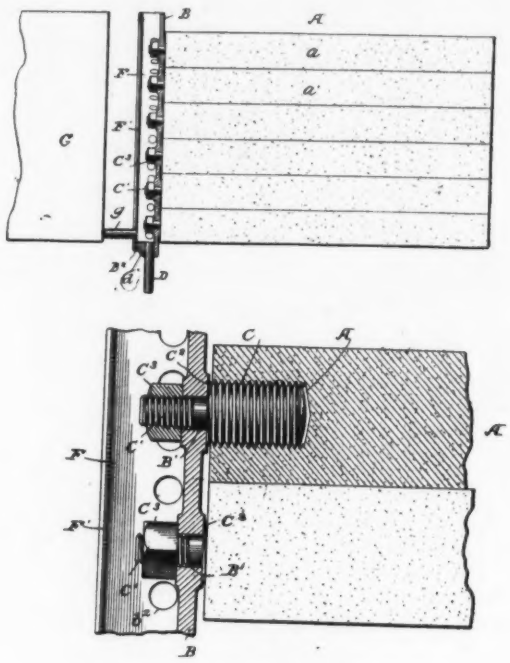
Mr. Acheson concludes a description of his new terminal for resistance furnaces with the following words: "For instance, when these graphitized-carbon electrodes (72 in number) are individually 16 inches in cross-section, so that the total cross-section of the terminal is 1,152 square inches, a current of 37,500 amperes can be carried on the terminal with safety and efficiency." This well expresses the magnitude of the problem of conducting the current to a modern electric furnace.

As shown in the accompanying figures, a series of blocks *a* of graphitized carbon, placed in close relation to form a single terminal, *A*, are secured to a copper plate, *B*; this plate constitutes the inner wall of a water-tank, *F*, the sides and bottom of which are formed by the peripheral flange B^2, and the back by the sheet-metal plate F^1. A pipe, *g*, affords communication with a larger tank, *G*, in which a constant level may be maintained. The essential feature is the connection between the graphite blocks and the plate *B*, which is effected through copper plugs, C, screwed into cavities, A^1, in each of the component graphite blocks. These plugs are provided with external bearing surfaces, C^2, and reduced extensions C^1, whereby the copper plate may be closely clamped by bolts C^3 without exerting any undue strain upon the graphite itself. Connection between plate *B* and the external circuit is made through a series of copper connectors, equal in number to the graphite blocks, and sweated into openings b^2 in the flange B^2.

GLASS MAKING IN THE ELECTRIC FURNACE.

Reference has frequently been made to the several promising applications of the Nernst principle to the manufacture of glass. A patent issued to August Voelker, of Ehrenfeld, Germany, would appear to involve a backward, rather than a forward, step, inasmuch as he proposes to mix with the ground raw materials a sufficient quantity of graphite or metal powder to render the same a conductor. Owing to the high coloring powers of the metals, they





TERMINAL FOR ELECTRIC FURNACE.

can be used only for the production of special grades of glass; and if graphite be used, there must be added a corresponding amount of an energetic oxidizing agent. It would seem also that the high ash content of most graphites would enter as a disturbing factor.

TREATMENT OF ANTIMONY ORES.

Jarig Van der Ploeg, of The Hague, patents anew the method described in 1889 by Schreiber and Knutsen, for the separation of antimony from simple or complex ores. The leaching agent employed is a solution of calcium sulphide, to which a proportion of hydrate is added to reconvert any polysulphides formed into the lower sulphides, which are more soluble and better electrolytes.

Rubber Covered Wire for Service Connections.

One of the questions asked at the Cincinnati Electric Light Convention was whether the service-wire insulation recommended by the National Underwriters' Code is desirable. An answer submitted by "L. A. M." is that rubber covered wire is unfit for insulating purposes if exposed to the weather unless covered with weatherproofing.

New Telephone Patents.

Owing to lack of space, notice of several of the telephone patents issued June 3 did not appear last week, and is now given below:

Three inventors, Messrs. Wilton A. Williams, Oscar L. Ingram and John B. Wilson, all of Walla Walla, Washington, have collaborated to produce a party-line call of the step-by-step variety, which is not without its ingenious features, but is about as complicated and costly as the usual device of this class. The action is to make a contact-maker rise to a certain position by means of a series of impulses and then descend slowly, the descent being checked by a dash pot; at the right station the contact arm will meet in its descent a contact plate and so establish the bell circuit. The bell circuit will not be made at the other stations; at those corresponding to fewer impulses than the number sent the arm will not reach the contact plate, and at those corresponding to a greater number

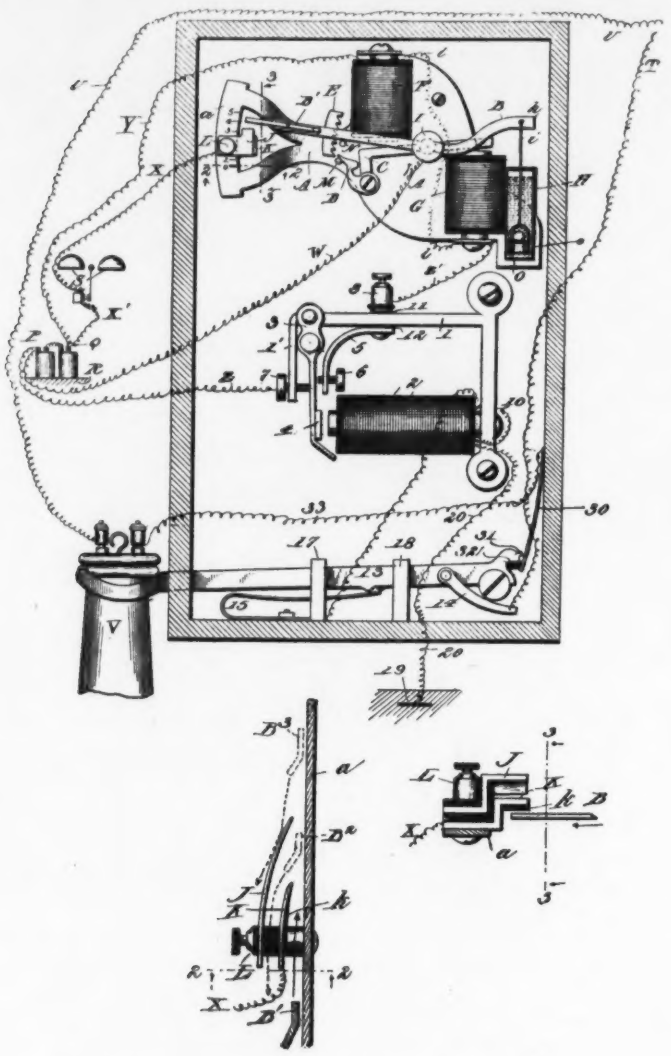


FIG. 1.—TELEPHONE CALL FOR PARTY LINES.

the arm fails to make contact, as in going up it passes underneath the plate, which is insulated on its lower surface, and in coming down it is fended off and prevented from making contact by a guard projection beyond the contact plate. In the drawings (Fig. 1) the complete apparatus is shown, and details of the contact plate and guard. The lever B is raised by the armature C, pawl D and ratchet E fixed to B; C is controlled by the magnets F and G, which are in a local circuit with battery R, governed by the relay 2 connected to line. The arm B carries contact spring B^1, and its descent is checked by the dash-pot H, so that after having been raised by the action of the magnets B^1 shall fall slowly over the arc a. At a different point on the arc a at each station is fixed the post L, carrying the contact-plate K, having insulated lower surface, K, and the insulated guard strip J. As shown in one drawing the arm B^1 in going up passes underneath K and is insulated from it by K; in coming down it will either pass over K, establishing the required contact, or will be fended off by J, according to the height to which it has been raised. If the series of impulses have carried B^1 to the position shown at B^2, and B^1 is then allowed to fall it will make contact with K; if the impulses have carried B^2 to the position shown at B^3 it will in falling be deflected by J, and, riding over J, fail to make contact with K. Therefore, by setting K and J at different points on the arc at each station it is clear that a given series of impulses will bring B^1 and K into contact at only one station, and will fail to bring them into contact at any other.

A patent on a telephone system, employing a single line wire not grounded at either end, granted to Charles G. Burke, of Brooklyn, is due to an interesting phenomenon observed by the inventor which is that by connecting a second induction coil in circuit on a telephone line with the secondary connected to line and the primary to a local circuit containing a battery and a telephone receiver wound to a low resistance the action of the telephone is very greatly improved and it gives a much louder and clearer effect. Mr. Burke further has discovered that with the use of such local circuits containing both the battery and receiver he is enabled to transmit speech practically over a single ungrounded line wire, including at each end the long fine-wire coils of the induction coils, the short coarse-wire coils of which are included in the local circuits. In the drawings, the upper portion of Fig. 2 shows the arrangement just described. Mr. Burke says it is important that the corresponding ends of the secondaries, S S', be connected to line. If two receivers be used at each end of the line, one connected with the line and the other with the local circuit, greatly improved results will be obtained. Such an arrangement is shown in the lower figure. In this arrangement there are added the coils F C, F' C', the secondaries of which are

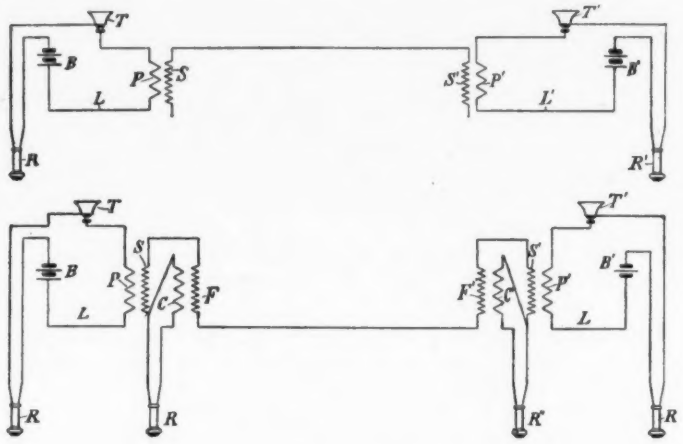


FIG. 2.—BURKE'S TELEPHONE SYSTEM.

connected to line and the primaries to receivers R' R'', the free ends of the secondaries S S' of the original coils being also connected to the corresponding ends of C C'. In this case also, says Mr. Burke, a certain order of connection must be observed; if the outside end of S is connected to line, the corresponding end of S' must also be connected to line, and F F' must be connected so as to bring their outer ends in connection with the outer ends of S S'. The inner ends of C C' must be connected to the inner ends of S S', respectively, to secure the best results. Mr. Burke says that he has found the above-described arrangements of circuits and apparatus to yield much better results than are obtainable with the same class of instrument when used in the ordinary way. It would be interesting to know over what length of actual line and under what conditions Mr. Burke has tried his novel circuit.

Telephony contributes but one patent to the issue of June 10, the inventor being Mr. James M. Overshiner, of Elwood, Indiana, and the invention a combined drop and jack with self-restoring mechanism, actuated by the movements of the plug. In the accompanying illustrations the upper figures show a front view and section of the drop and jack, and the remaining figures illustrate the conditions at various positions of the plug. The front plate, 2, is slotted at 7, the slot having a lower curved face, 9, and an upper curved face, 8; 9 serving as a cam-surface in guiding the movement of the restoring slide, 10. The slide 10 has a bent rear arm, 11, which depends through an elongated slot in the jack-tube, 1, and terminates in the path of the plug. The front of slide 10 is hook-shaped, having shoulder 12 to ride on cam-surface 9 and tip 13 to engage the drop-

shutter 3. The slide 10 is held normally outward by spring 14, and normally upward by a small lever, 15. This lever is pivoted to tube 1 by a pin, 16, passing through a slot, 17, in the lever, whose lower arm normally projects a sort distance into the tube.

When the drop falls, the shutter is caught by end 13 of slide 10, as shown in the upper of the plugged views. When the plug is inserted it will first raise the lever 15 and pass it, not causing it to be thrown forward because spring 14 blocks a forward movement of 15. The slot 17 permits 15 to be raised to the position shown in Fig. 2, the end of 15 riding on the plug. When the end of the plug has passed

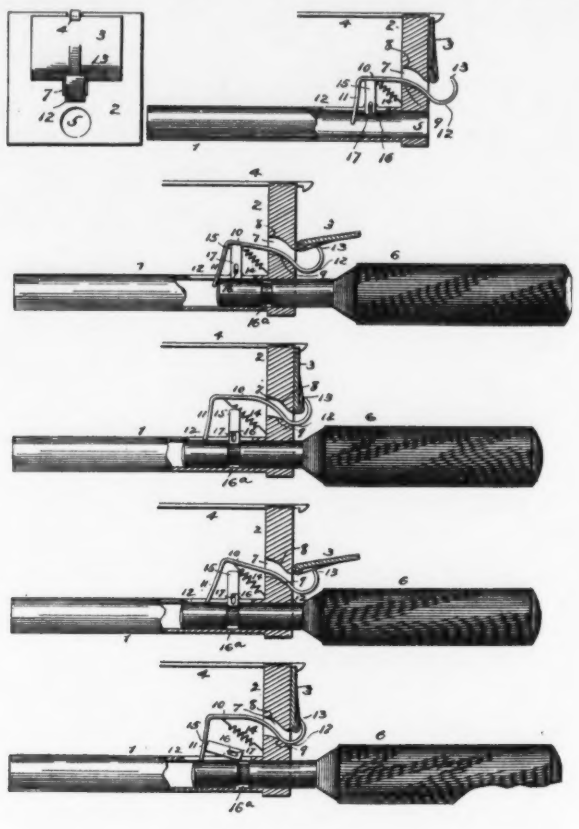


FIG. 3.—OVERSHINER'S COMBINED JACK AND DROP.

15 it will meet arm 11 of slide 10, pushing it upward and inward, and shoulder 12, riding on the cam-face, 9, the hook 13 will rise and close the drop-shutter. When this shall have been accomplished, the lower end of 15 will have entered groove 16a in the plug, and be thus retained in an upright position, as shown in the following figure. When the parts have reached the position shown in the figure below, spring 14 will act to withdraw the slide to its outward position. When the drop again falls, the signal is for clearing out, and the withdrawal of the plug again restores the drop by the action of lever 15, which by groove 16a is swung on its fulcrum as the plug is retired and causes the slide 10 to be again forced back. When the plug is entirely withdrawn the spring 14 returns 10 and 15 to their normal positions.

CURRENT NEWS AND NOTES.

ELECTROCUTION IN INDIANA.—A bill to substitute electrocution for hanging as capital punishment in Indiana will be introduced in the next Legislature.

THE COMMERCIAL PACIFIC CABLE.—Advices from London are to the effect that a thousand-mile section of the Commercial Pacific Cable Company's cable, to be laid between San Francisco and Honolulu, has been completed.

MARCONI'S NEW WORK.—A cable dispatch from London, of June 13, says: In the course of a lecture to-night before the Royal Institution of Great Britain, William Marconi announced that he had invented a highly sensitive magnetic detector of electric waves, by which it was possible to read about 30 words per minute in wireless telegraphy.

WIRELESS TELEGRAPH SYSTEM FOR HAVANA.—The steamship "Morro Castle," of the Ward Line, which sailed from New York last Saturday, carried the De Forest-Smythe wireless telegraph system, which is to be installed in Havana. For several hours after sailing, the "Morro Castle" remained in communication with the De Forest-Smythe stations, at Staten Island and Coney Island. Details of his work, by Mr. De Forest, have already been given in our pages.

AUTOMOBILISTS SET FREE.—No indictment was found by the Richmond County grand jury, last week, against W. C. Baker and D. E. Denzer, who were under bonds to answer a charge of homicide in having caused the death of Andrew Featherstone and John G. Bogart by the running wild of their electric automobile at the automobile speed trial held on Staten Island, on May 31. The grand jury handed down a recommendation setting forth that it is advisable that no further public automobile races or steam tests of automobiles or other automobile vehicles be held on any public highway in the County of Richmond.

THE PARIS UNDERGROUND.—A cable dispatch from Paris, of June 14, says: Another long section of the Metropolitan Underground Railway, from the Chaussée de Clignancourt to the Boulevard Magenta, has just been completed. The cost of construction of each kilometre thus far has been 4,500,000 francs ($900,000), or $1,440,000 per mile. Each kilometre also cost the life of one workman. It will be seven years yet before the whole system is completed. Visiting New Yorkers are astonished to see how little disturbance is being made by the contractors. The entire work is carried on underground, with only an occasional small shaft opened from the surface.

U. S.-GERMAN CABLE BUSINESS.—The annual report of the German Atlantic Cable Company, which has just been made public, and which covers the first full year of the company's operations, shows that the number of words transmitted by the company between the United States and Germany and *vice versa*, in 1901, was greater than the number of messages it was estimated would be sent between the two countries by all lines in 1898. The year of 1901 was the record year in transatlantic cable business. The new cable between Germany and the United States, which has been contracted for by the German Atlantic Cable Company, is to cost 21,000,000 marks ($5,250,000), and will be manufactured in Germany. The company's recent experiments in cabling direct from Emden to New York, without rehandling in the Azores, have been quite successful.

BROOKLYN SUBWAY.—It was intimated last week that the Belmont-McDonald syndicate, who are contractors for the Manhattan Subway, might offer to construct the Brooklyn tunnel at their own expense. The Rapid-Transit Board, at its meeting, decided that the work must be begun within 60 days of the letting of the contract, and that it should be finished within three years, but that the board under exceptional circumstances might extend the time for another year. It was agreed that a premium of 1 per cent. should be given for every month the contractor gains in pushing the work, and a fine of 1 per cent. levied for every month of delay. The period of the franchise was reduced from 50 to 35 years, with the privilege of renewal for a further 25 years, upon readjusted compensation. The clause against disfiguring advertisements remains.

ARTIFICIAL GRAPHITE.—The United States Geological Survey reports that the manufacture of artificial graphite has increased greatly, the production during 1901 amounting to 2,500,000 pounds, valued at $119,000, as compared with 860,750 pounds, valued at $69,860, in 1900, and with 162,382 pounds, valued at $10,149, in 1897, the first year of commercial production. The sole producer is the International Acheson Graphite Company, at Niagara Falls, N. Y. More than one-half of the output for 1901 was in the form of graphitized electrodes for use in the manufacture of alkali and bleach by electrolytic processes, the remainder being consumed in the manufacture of paints, lubricants, pencils, motor brushes, crucibles and dry batteries. The total consumption of graphite of all forms in this country is nearly 150,000 tons, almost 90 per cent. of which quantity is imported.

TIME SIGNALS WITH ELECTRIC LIGHTS.—The Harvard Observatory recently put into use a system of giving time signals with electric lights, which is intended to serve the same purpose as the daily noon ball, but with greater efficiency. This is the first signal of the kind established. They ought to be called Revere signals.

INVESTIGATING WIRELESS TELEGRAPHY.—A cable dispatch from Berlin, of June 9, says: Commander Francis M. Barber, U. S. N., (retired), ex-Naval Attache to the United States Embassy here, and Lieut. John M. Hudgins, U. S. N., who was ordered to Europe to receive instruction in the operation of foreign wireless telegraphic instruments arrived here to-day and began experiments with the Slaby-Arco system of wireless telegraphy. Experiments with the Braun system will be made later. Lieut. Hudgins will remain here for one month.

WESTERN UNION CHANGES.—The recent promotion of R. C. Clowry, general superintendent of the Western Division of the Western Union Telegraph Company, with headquarters at Chicago, to the presidency of the company, says the San Francisco *Chronicle*, is responsible for a number of changes among officials of the company throughout the country, not the least important of which is the promotion of Frank Jaynes to the position of general superintendent of the Pacific Coast Division. The Western Union has planned to have four grand divisions instead of three, as heretofore. The Western Division, which now embraces all of the company's lines west of Pittsburg, is to be divided into two jurisdictions, Mr. Clowry's successor, with headquarters in Chicago, taking charge of the Eastern end of the division, which will be known as the Western Division, and Jaynes taking charge of the Pacific Coast Division, with the title of general superintendent of the coast division. His headquarters will continue to be located in San Francisco.

CHESS BY WIRELESS TELEGRAPH.—The Cunard Line steamship "Campania," which arrived Saturday last from Liverpool, enjoyed a unique experience on the passage. On Tuesday, June 10, the wireless telegraph operator, Mr. Gannon, got in communication with the American Line steamship "Philadelphia," bound to New York from Southampton. When first heard, the "Philadelphia" was about 70 miles ahead of the "Campania." After passing the usual courtesies, the "Campania" suggested a game of chess, which was agreed to by the "Philadelphia." Notice was posted in the music room of the "Campania," and a passenger was found to play. The "Philadelphia" announcing readiness the game commenced at 2 o'clock in the afternoon, and lasted till 6:45 in the evening. At this time the "Campania" came in touch with her sister ship, the "Lucania," bound from New York for Liverpool, and being obliged to attend to business communications, the chess game was suspended, and was not resumed. At the time of the suspension of the game, the "Campania" had the best of it.

ILLUSTRATING APPARATUS.—A patent was granted June 3 to Frederick S. Newman, of Springfield, Mass., on an apparatus for use in halls, theaters, etc., whereby the incidents of a baseball or other game may be recorded in the order of occurrence. The apparatus shown in the engravings is adapted specially for reporting the details of baseball games. On a curtain is a diagramatic view of a baseball field with the positions of the various players. There are also various blank tables in which to record the various events of the game. In connection with the screen is a keyboard which may be located at any point convenient for receiving telegraphic messages. By manipulating the keyboard a reflector lamp is lighted to represent the event which it is desired to record. Transient events are also recorded, such, for example, as the course of a ball from start to finish, a lamp lighting when a ball is struck and going out as soon as the ball is thrown. In this manner a fly ball, for example, striking the right field is indicated; foul balls are visually denoted, etc. If a player on the side that is in the field puts out a player trying to make any of the bases, or to score, the operator will cause the lamp at the station of the player who did it, to be lighted, and also the lamp, at the base where the player was put out, in order to show the audience who put the player out and where it was done. The instrument appears to provide for recording visually every event of a baseball game.

LETTER TO THE EDITORS.

The Effect of Electric Waves on the Human Brain.

To the Editors of Electrical World and Engineer:

Sirs.—I have read the article in your issue of May 31, in which Messrs. D. McIntosh and J. Graham-Willmore criticize the methods described in my article in your issue of Feb. 22, which were employed in some experiments showing that brain matter is sensitive to impinging electric waves, and in turn, I beg to offer some criticisms on the methods employed by these gentlemen.

Referring to their use of a spark-gap ranging from 2 to 5 cm., it is common knowledge that the spark-gap of any oscillator system, though fed by a secondary current having a difference of potential of 100,000 volts, should be cut down to at least 0.5 cm. Not that this wide divergence from practice would cause the oscillator to fail in its emission of electric waves, but with a spark-gap 5 cm. in length a coil having a maximum spark length of 40 cm. would be required to effect the proper balance. Likewise the resonators, we are informed, were brass rods 7 feet long. With this gigantic transmitter, capable of propagating electric waves 500 miles—if properly adjusted—Messrs. McIntosh and Willmore tested the coherer at 4, 10 and 25 feet from the coil. At this distance a coil giving a maximum spark of 2 cm. will act upon a properly constructed coherer *without any disrupted discharge* through the field of force set up by the surging of the low-frequency, high-potential currents alone.

With Messrs. McIntosh and Willmore's apparatus, the room must have been filled with the invisible electric waves, and its effect on matter subject to cohesion similar to that produced on the organ of superior discriminating power by a 50,000-cp arc lamp suspended in the center of a 12 x 14 room, with walls formed of French-plate mirrors. Under these conditions the tests were made.

Messrs. McIntosh and Willmore mention the coherer they used as a standard, but refrain from describing it. If it was proportionately as large as the rest of their apparatus, it would be an interesting addition to the literature on coherers to have an unabridged description of it.

These gentlemen also state that they placed an accumulator in series with the coherer and millivoltmeter. An accumulator is most excellent for operating an automobile, but for delicate tests of electric waves, a single dry cell is more than sufficient. Considering the enormous plant used by Messrs. McIntosh and Willmore, if any deflection of the needle had been observed under these circumstances, I should have attributed it to electrostatic stresses in the intervening dielectric and not to electric waves, for unless every precaution is taken, especially with very large coils, it is almost impossible to eliminate such untoward disturbances. In delicate experiments with electric waves there is another factor, which, overlooked as it was by Messrs. McIntosh and Willmore, precludes the probability of any testing instrument working properly, if at all; this is the rapidly-alternating magnetic field created. For these reasons I prefer a 2-cm. spark coil, as it is then easy to screen such effects from the receiver.

Leaving the physical for the psychological side of the case for a moment, a curious phase of Messrs. McIntosh and Willmore's position is their willingness to accept hypnotic suggestion as the cause of death of a weakened, nervous, disease-stricken patient, who, as they declare on the authority of a pre-anæsthetic surgeon, "died when the finger-nail was drawn over the perineum marking the line of incision." Had Messrs. McIntosh and Willmore said the patient died *after* the surgeon had performed a successful operation, the facts in the case would have been much more clear. It is remarkable that men trained in experimental physics should be so ready to accept hypnotic suggestion—which is itself synonymous with action at a distance without physical contact—as an easy explanation for every obscure psychological and physiological phenomenon. Apropos, it would be interesting if Messrs. McIntosh and Willmore would make known their explanation as to why "birds are affected by the approach of a storm." In this they admit that there is a connection between the storm and the birds. If this connection is not electrostatic or due to electromagnetic influence, what is it? If the gentlemen belong to the Boscovitch eighteenth century school of action-at-a-distance through absolute vacuum, I wish to be counted out of the argument.

In another part of their article they would have the reader accept

as a fact that which remains yet unproven, namely, that the brain conducts by electrolytic action. The idea that brain matter is analogous with alkaline solutions may be quickly dissipated by heating a solution of chloride of sodium until the water is expelled, when salt will remain; then heat a small cross-section of the "moist brain material" in the same manner and it will carbonize. Dry salt is a non-conductor of electricity, carbon a conductor. When the electric waves act on the brain cells it carbonizes particles of it between the conductor plugs, however small the carbonization may be. The description of the terminal conductor plugs employed in Messrs. McIntosh and Willmore's tests is so meagre that comment is not possible, yet these are vitally important factors in making successful tests.

Messrs. McIntosh and Willmore are presumptuous in supposing I would object to the brain of a bird for impromptu test purposes; I rather admire it, especially since Lodge has mentioned that the *trilobita* had a cavity sensitive to electric waves; but what I do strenuously object to is having my experiments tried with apparatus different from that with which I succeeded; however defective my method seemed to others, it was effectual. It also seems to me that since the experiments I made were qualitative and not quantitative; and that inasmuch as the telephone receiver is a hundred times more sensitive than a Weston millivoltmeter, it is not such a crude instrument, or the method I employed so defective as my Canadian critics believe. And while condemning the telephone method as defective, in an unobtrusive little footnote they tell how easy it is to measure the resistance of the brain by means of an alternating current and a telephone. They evidently are not aware that Mr. Marconi used a telephone receiver in his great transatlantic cableless experiment to detect the cohesion of the metal filings produced by the impinging electric waves, and I have no doubt that Mr. Marconi would have employed a millivoltmeter if that instrument stood in the same class with the telephone receiver for sensitiveness.

If Messrs. McIntosh and Willmore were to try to repeat Mr. Marconi's long-distance cableless test using their millivoltmeter, would they expect to obtain results? The moral of this controversy is, that if you don't succeed with apparatus of your own devising, try again and follow the specifications of those who did succeed.

NARBERTH, PA. A. FREDERICK COLLINS.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Commutators of Direct-Current Dynamos.—ROTHERT.—An article, illustrated by diagrams, on the question of how many commutator segments a direct-current dynamo should have. He starts from Parshall and Hobart's method for calculating the coefficient of self-induction of a short-circuited armature coil and develops formulas for determining the number of commutator segments. Other conditions being equal, the number of segments for the same type of machine should be proportional to the voltage at the terminals. A small breadth of the iron is favorable, *i. e.*, it is to be recommended to build narrow armatures with large diameters. A strong field is also favorable.—*Elek. Zeit.*, April 10.—A correction in one of his discussed at some length in a communication by Dick, who compares formulas is given by him in *Elek. Zeit.*, May 8.—The article is also Rothert's formulas with those of others, and points out that in order to determine the required number of commutator segments, under the assumption of a certain reactance voltage, the influence of the field cannot be neglected—*Elek. Zeit.*, May 1.

REFERENCES.

Stray Flux of Dynamos.—CORSEPIUS.—An abstract of a paper read before the Dresden Elec. Society. In direct-current as well as in alternating-current dynamos the stray fluxes of lines of induction depend upon the armature current. If it is no direct current, the stray flux changes during each alternation; not only does the amount in per cent. change, but also the total amount of the unutilized magnetism. This is explained by analogies and by direct demonstration.—*Elek. Zeit.*, May 1.

Shunt Regulators.—KRAUSE.—An article, illustrated by diagrams, in which he describes a method for determining the steps of the regulating resistance of shunt generators with self-excitation.—*Elek. Zeit.*, May 1.

Formers.—DAVIES.—A third article on formers and former-windings. This part deals with formers for ring armature cores.—Lond. *Elek. Eng.*, May 23.

Polyphase Induction Motor.—A brief critical remark, by Lindstroem, of Ziehl's recent description of an induction motor; and a reply by Ziehl.—*Elek. Zeit.*, April 10.

LIGHTS AND LIGHTING.

Lighting of the St. Paul's Cathedral.—An illustrated description of the electric lighting installation of St. Paul's Cathedral, in London. The wires have been run in iron barrel, and the lateral distribution is mostly hidden beneath the floor of the crypt, where inspection boxes are placed at frequent angles and intervals. The vertical cables have, when possible, been carried in the hollow centers of the main piers. The distributing board system of wiring has been used on the two-wire system, and current is taken from the mains of two different companies, duplicate circuits having been laid throughout the building, so that alternate groups of lamps are fed by the two companies. The pressure adopted is 200 volts, and very large cables have been used to compensate for the long runs, the current density allowed for being 250 amperes per square inch. The iron barrel is not insulated in any way, the rubber covering of the wires and an additional layer of tape being relied upon. All the fittings in the chancel, dome and nave are provided with an especial form of molded glass globe, which is said to be the result of many experiments and which has been found to act as an excellent dispersant of light. Some original tests with plain lamps and the globes showed that the use of the latter enabled a reduction of about 200 cp in the nave to be made for the same illumination. The lamps range from 32 cp to 5 cp.—Lond. *Elec.*, May 30.

POWER.

REFERENCE.

Electricity in a Shipyard.—O'HARA.—A very long and profusely illustrated description of the electric installation in the plant of the New York Shipbuilding Company, in Camden. Direct current is used for the enclosed arc lamps and the crane motors, while alternating current is used for driving the machine tools; the powerhouse contains two 500-kw double-current generators. A very elaborate system of cranes is in use. For the machine tools induction motors are used throughout. Shafting was almost completely eliminated throughout the works.—*Cassier's Mag.*, June.

TRACTION.

Train Resistance.—DAVIS.—An article in which he replies to the criticisms of Lundie, Bell, Dodd and Wille upon the author's original paper, recently noticed in the Digest, in which he presented his formulæ, based on the results of the Buffalo and Lockport test. The author calls attention to the fact that these experiments were made under conditions similar to those of former experiments with steam locomotives, the only difference being that in the Buffalo and Lockport tests an electric locomotive was used. He compares some of the best known formulas and calls attention to the fact that with the exception of the Wellington test, the number of cars forming a train, or the cross-sectional area of the car, were not taken into consideration. Attention is also called to the fact that in the Buffalo and Lockport tests none of the coaches were of the vestibuled type, and the outline of the electric locomotive was such that it and the car following presented practically a flat surface to the wind. The other type of interurban electric car is vestibuled at both ends, and consequently presents a partially rounded or wedge-shaped end to the direction of motion. This, of course, will modify somewhat the

data obtained from the tests with cars presenting flat surfaces to the wind.—*St. R'y Jour., Int. Ed.,* June.

Special Tests vs. Commercial Practice.—James.—A communication reviewing the discussion about Mr. Davis' formulas, and suggests that it might be well to apply the results that have been obtained in commercial practice. The writer contends that enough high speed runs have been made by electric cars in the neighborhood of 60 miles an hour to prevent any alarm being felt on account of the danger of reaching a prohibitive figure, due to the train resistance. The writer calls attention to the tests on the Lake Electric Railway, which are published in this issue, as supporting his position. He favors the explanation that there is possibly some error in the conclusion which would probably be developed by a careful checking of the readings of the ammeter and voltmeter just before current was cut off, where the coasting method is employed.—*St. R'y Jour., Int. Ed.,* June.

Tests for Air Resistance on the Berlin-Zossen Experimental High-Speed Line.—An article briefly describing the principal features of the conditions under which the high-speed tests were made, and gives the plotted results of the wind resistance tests. Two cars were used, one furnished by the Gen. Elec. Co., of Berlin, and the other by Siemens & Halske. The fact is brought out in one curve that the wind resistance varied as the square of the velocity. Figures on the total train resistance are not yet available, but are promised in an early issue. The experiments have been stopped for a while, as the track proved to be too weak for the service. As soon as it is strengthened, runs at higher speeds will be made.—*St. R'y Jour., Int. Ed.,* June.

Berlin-Zossen Tests.—A review of a consular report containing an abstract of Lochner's paper on this high-speed line, the text of which, however, has been withheld from publication. Comment is particularly made upon the lightness of the track construction. For high speeds it is pointed out that the rails should weigh 90 lbs. to 100 lbs. per yard, and should be specially designed to meet the exacting conditions of this class of work. Moreover, a solid roadbed under the rails is absolutely necessary to secure the best results. The writer expresses the views of most American engineers when he says that much more favorable opportunities would be offered for developing high speeds by making similar tests on the New York Central and Pennsylvania roads. Much doubt is expressed, however, on the probability of American engineers securing any place in the development of this class of work.—*St. R'y Jour.,* May 17; *Int. Ed.,* June.

High-Speed Electric Trains Between Cleveland and Toledo.—A description of the tests that have been made by the Lake Electric Railway Company with a view to determining the possibilities of fast through cars from Cleveland to Toledo, a distance of 118 miles. The company is putting the road in shape to operate limited cars between these cities in four hours, which would mean a sustained speed of 29½ miles per hour, allowing for all stops, and the 44-minute schedule for 7 miles in Cleveland, and 26 minutes for 2¾ miles in Toledo. The car used in the tests mentioned is built very much like a steam railroad coach. Some tables are given, showing the actual time between the stations on the road in regular passenger service and on a special run. In the latter case, the loaded car weighed 36 tons, but the conditions were such that it is difficult to anticipate just what results will be obtained when the road is thoroughly equipped for this service.—*St. R'y Jour.,* May 17.

Electric Freight Locomotive.—An illustrated description of a new electric locomotive, built for heavy freight service on the Hudson Valley Railway between Albany and Warrensburg, N. Y. This locomotive is intended for hauling regular steam road freight cars between the points mentioned, the line passing through a country that is filled with mills and factories. The dimensions of the locomotive, mounted on trucks, are as follows: Height from rail to top of body, 12 ft. 11½ ins.; extreme height over trolley span, 13 ft. 6 ins.; length over end sills, 25 ft.; length over buffers, 27 ft.; extreme width, 8ft. 3ins. The heaviest possible construction has been adopted. There are four 100-hp motors; air brakes and automatic couplers are provided. A track sanding device, operated by compressed air, has also been adopted. Including the trucks, the weight of the locomotive is about 30,000 lbs., and with the motors and air brake equipment it will be increased to 50,000 lbs.—*St. R'y Jour.,* May 10.

Regulating the Voltage for Car Lighting.—Schuh.—An illustrated description of a simple method for keeping the voltage of the lighting current in electric railway cars constant within given limits; it is in satisfactory operation on a road in Switzerland. As relay, a revolving system of the Deprez-d'Arsonval type is used. An armature is provided with three different contact arms. When the current increases, the armature is turned and the three contact arms close circuits which contain electromagnets; the latter attract armatures which again close circuits containing the resistances, by means of which the voltage is kept constant.—*Elek. Zeit.,* April 3.

Restrictions on the Controller Handle.—Cravath.—An article in which he reviews the many plans that have been proposed for restricting or automatically regulating the rate at which current is turned on in starting an electric car or train. The injurious effects of the rapid turning on of current have been evident even from the earliest days, and particularly on a light equipment. Even with the heavier motors and better construction of to-day, the sudden inrush of heavy current often repeated will seriously impair the motors and finally result in break-downs. The writer points out that there is a great waste of energy at the present time in the ordinary operation of cars. The practice which results in these serious losses is also objectionable, because of the inconvenience to which the passengers are subjected in the jerking motion of the car in starting and stopping. What is needed in city service is smooth and rapid acceleration from the first to the last point of the controller. Experience seems to have demonstrated that it is impossible to secure this service without the use of an automatic device.—*St. R'y Jour.,* May 24, and *Int. Ed.,* June.

Broken Trolley Wires.—An article in which superintendents are urged to give special attention to the points on the line that are subject to the greatest wear. A little care originally in the construction of these lines will go far toward minimizing chances for accidents. It is now recognized that No. 4 wire is not large enough to last for any length of time, and that a rigid suspension for the hanger is inferior to one that is more flexible; also that long ears which taper off until they become thin and similar construction in overhead switches and frogs, are better on straight tracks than short ears or frogs with ends of no flexibility. It is suggested that attention be given to the question of sag and overhead alignment, as these two features comprise the entire problem of the mechanical erection of the trolley wire. The writer believes that if the overhead line is kept taut by being pulled up and let out at expansion ears about four times a year, to allow for expansion and contraction, the pressure of a pole with a light trolley wheel could be reduced greatly, which would, of course, lessen the wear on the overhead line. The writer also expresses doubt as to whether the circular section for the wire is in all respects preferable, as European experience indicates that ribbon-shaped wire, with rounded edges, is very serviceable.—*St. R'y Jour.,* May 17, and *Int. Ed.,* June.

Street Railway Management in Texas.—Stuart.—An abstract of a recent paper read before the Southwestern Gas, Electric and Railway Association, at San Antonio. He emphasizes the necessity for establishing a schedule and observing it very closely. The paper is intended for the information and guidance of managers of the smaller class of properties, and has particular reference to the development of new business. For companies, however, that have a large clientele, the policy of establishing and encouraging places of public amusement along the route is advocated. Some hints to managers upon the treatment of men employed in various capacities are given.—*St. R'y Jour.,* May 10.

REFERENCES.

Mountain Railway.—Bignami.—An illustrated description of the Vevey-Mont Pelerin road, which is a cable operated mountain railway in Switzerland, the cable being driven by an electric motor. There are two 30-hp gas engines, driving direct-current dynamos. There is also a battery intended to aid the generating station at the moments of heavy load when it discharges in parallel with the generators; at times of small load it is charged; by this arrangement the generators work constantly at full load.—*Eng. Mag.,* June.

Great Variations in Trolley Wheel Wear.—An editorial note suggesting a comparison of trolley wheel wear on high-speed interurban roads operating heavy cars, as inquiry among managers of such properties shows a much greater variation of the life in miles than can reasonably be accounted for. The average life of trolley wheels on the heaviest and highest speed cars varies on different roads from 500 to 5,000 miles, which, of course, is altogether too wide a margin.—*St. R'y Jour.,* May 24.

INSTALLATIONS. SYSTEMS AND APPLIANCES.

Electric Lighting in Spain.—A note stating that electric lighting makes rapid progress in Spain. There are 588 central stations, of which 35 are in the county of Madrid and 14 in the city of Madrid. The progress is due to the high price of coal and to the abundance of water power. The 96 meter high falls of the Manzanares are being utilized, and the work has progressed so far that for Madrid 500 hp are already available.—*Elek. Zeit.*, April 10.

Feeder Regulators.—GESING.—An article on the practical and rapid calculation of feeder regulators for lighting circuits, *i. e.*, of the adjustable resistance which when inserted in a line, enable one to adjust the voltage at the consumer's terminals within a small permissible limit of variation of voltage. He has calculated a set of numerical tables, which are reprinted, by means of which the calculation of these resistances is rendered easy.—*Elek. Zeit.*, April 3.

WIRES, WIRING AND CONDUITS.

REFERENCE.

Economical Cross-Section of Conductors.—CAHEN.—A communication in which he discusses at length Teichmueller's article on the calculation of the economical cross-section of conductors (Digest, May 3). He agrees that the matter is of great importance, but doubts whether Teichmueller's method of calculation could be used to advantage in practice.—*Elek. Zeit.*, April 3.—A long reply by Teichmueller to this criticism in *Elek. Zeit.*, May 22.

ELECTRO-PHYSICS AND MAGNETISM

Cathode Rays.—STARK.—An account of an experimental investigation of the reflection of the cathode rays. When a pencil of cathode rays impinges upon a surface, some of the electrons penetrate into the surface and are absorbed; others may be transmitted; the rest are reflected. Those reflected may either have been turned back at the first encounter with the surface, or the particles may have penetrated some distance into the surface, having been deflected by central forces, and threaded their way out again. He has studied the manner in which both these reflections depend upon the angle of incidence. The relation varies from metal to metal, "as might have been expected, since some metals, like aluminum, absorb the electrons more easily on account of their large atomic volume."—*Phys. Zeit.*, May 15; abstracted in Lond. *Elec.*, May 30.

Conductivity of Insulating Liquids.—DI CIOMMO.—A study of the effect which mixing two liquids of high resistivity has upon their electric conductivity. Benzol, toluol, hexane, ettane, carbon bisulphide and chloroform were experimented with. The resulting conductivity cannot be directly calculated from the conductivities of the constituents and the proportion in which they are mixed. "The results show that ionizations cannot be simply added as they can in extremely dilute solutions of electrolytes, and that the mixture of two dielectric liquids interferes with the normal behavior of the ions of each separate liquid."—*Phys. Zeit.*, May 15; abstracted in Lond. *Elec.*, May 30.

REFERENCE.

Electromagnets.—VARLEY.—An illustrated article on machines for winding electromagnet coils.—*Elec. Age*, June.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolytic Production of Copper.—EGLI.—A paper in which he first discusses the processes at a cuprous sulphide anode. In a sulphuric acid solution, copper dissolves as copper ions, while the sulphur precipitated gives rise to passage resistances. In a hydrochloric acid solution, copper will partly dissolve as copper ion, though there may be an excess of chlorine separated. The dependence of the ratio of cuprous and cupric ions on the density of current and acid, has not yet been determined, but he finds that under certain definite conditions cuprous chloride is formed. Sulphur will be oxidized to sulphuric acid by nascent chlorine. When cuprous sulphide is used as an anode in an alkaline solution, Bernfeld has found that the metal is converted into its hydroxide, the sulphur passing through all degrees of oxidation to sulphuric acid. When cuprous sulphide is used as cathode in an acid solution, Bernfeld has found that sulphuretted hydrogen will be produced at the cathode, the metal remaining at the electrode (in a manner analagous to Salom's electrolytic lead reduction), while in an alkaline solution sulphur dissolves as ion, the metal forming a muddy mass. The author confirmed these results. He then investigates the precipitation of copper from cupric chloride solutions. As rapid circulation of the electrolyte greatly diminishes the amount obtained, it should be only just sufficient to maintain uniformity in the electrolyte. The presence of hydrochloric acid, while assuring a greater purity of copper, will considerably diminish the efficiency of the process. The addition of *Na Cl* is favorable to purity, as it tends to prevent the formation of cuprous chloride, with only a slightly decreased efficiency. A large percentage of cupric chloride is unfavorable either to efficiency or purity, as it increases the formation of cuprous chloride; but the percentage should not be less than about 0.05 (gram?) molecule per liter, as the metal would then separate in a spongy state. Raising the temperature enables the current density to be increased, giving higher efficiency, the solubility of copper in the electrolyte not being sensibly affected thereby, as long as Faraday's law is satisfied. From an electrolyte containing 0.1 (gram?) molecule cupric chloride, 0.1 molecule hydrochloric acid and 0.4 molecule sodium chloride, a precipitate containing 99.90 to 99.98 per cent. of copper has been obtained. —*Zeit. Anorg. Chemie*, v. 30, No. 1. p. 18; abstracted in *Science Abstracts*, May.

Precipitation of Colloids by Electrolysis.—WHITNEY AND OBER.—Starting from the work of Linder and Picton on the precipitation of colloidal solutions of arsenious sulphide by solutions of barium chloride, they find that the precipitated sulphide of arsenic contains a definite percentage of barium in the case of dilute solutions of precipitant and sulphide solution; this percentage is independent of the amount of barium chloride used as precipitant or its concentration. When solutions of calcium chloride, strontium chloride or potassium chloride are used in place of the barium chloride, similar results are obtained. Moreover, the amounts of calcium, strontium or potassium in the precipitated sulphide are chemically equivalent. —*Zeit. Phys. Chem.*, Jan. 31; abstracted in *Science Abstracts*, May.

REFERENCES.

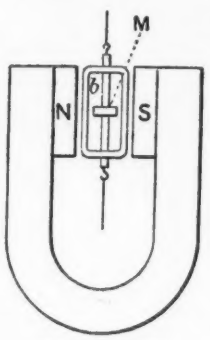
Electrolytic Process of Making Copper Tubes.—An illustrated description of the plant of the English Electrometallurgical Company, in which the well-known Elmore process for making copper tubes is in use.—Lond. *Eng'ing*, May 16.

Storage Battery Boxes.—A description of the methods of manufacture of vulcanite boxes for storage batteries.—*Centralbl. f. Accum.*, March 15; Lond. *Elec.*, May 23.

The Ions of Electrolysis.—BROWN.—A lecture given before the Brit. Royal Institution. He sketches the work of Hittorf and Kohlrausch and the development of the electrolytic dissociation theory.—*Science*, June 6.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Compensation for the Weakening of Permanent Magnets.—An illustrated description of a new type of instrument, devised by Weiss, and made by a French firm, with a view to eliminating the error due to the weakening, in time, of the permanent magnet in measuring instruments of the Deprez-d'Arsonval type. The instrument, as diagrammatically shown in the adjoining figure, consists essentially of a moving coil, *b*, deflected by the field of a permanent magnet, *N S*. The elastic force of the suspension wires is made as low as possible. The controlling force is mainly obtained by means of a small piece of soft iron suspended in the axis of the moving coil. The greater part of the controlling force results from the field of the magnet *N S*, acting on the induced magnetism of the iron *M*. A weakening of the magnet *N S* will thus decrease the controlling force at the same time as the deflection force. The weakening of the magnet will, therefore, have no effect if a proper relation exists between the dimensions and magnetic density of the magnet *N S*, the iron piece M, and the elasticity of the suspension wires. The time variation in these latter will have no influence either, since their action has now been made practically negligible. It is stated that as much as 20 per cent. variation in magnet strength does not result in any change in the calibration curve. An aluminum spool carries the coil, and this dampens the oscillation of the coil. Moreover ,the light weight, when pivoted on jewels, allows the apparatus to be placed in any position without any sticking or perceptible friction. Thermic variations are avoided by the use of manganine wire.—Lond. *Elec.*, May 30.



COMPENSATED INSTRUMENT.

Measurement of Power in Alternating Current Circuits.—GOERNER.—An article, illustrated by diagrams, in which he first discusses the various difficulties in measuring the power in alternating-current circuits. The power is always the product of effective current, effective e. m. f., and power factor; but the value of the power factor depends upon the wave form; only for pure sine waves is the power factor equal to the cosine of the phase difference between the e. m. f. and current waves. In practice the wave form of the e. m. f. is often different from that of the current, and neither is a sine wave. He points out the consequences of these facts in various methods of measuring. For instance, the method of the three voltmeters will give wrong results in most cases. While the hot wire voltmeters and ammeters are entirely independent of the wave form, the hot wire wattmeters are not independent, and, in general, any method will give wrong results, in which the geometric sum of currents or e. m. fs enters into the calculation of the power. He says that the only safe method of measuring power is one in which the mean value of the products of the instantaneous values of current and e. m. f. is measured directly, and for this purpose there exists at present only one exact instrument, namely, the dynamometric wattmeter; all other instruments which are based upon the principle of induction have certain disadvantages, such as dependency upon frequency or upon wave form, etc. He then discusses in detail all requirements which must be fulfilled in order to make a dynamometric wattmeter give exact results. For instance, it is necessary to avoid all superfluous metallic parts and to make the main current coil of laminated copper so that the formation of eddy currents is avoided; furthermore, the self-induction of the shunt coil must be very small compared with the ohmic resistance. He describes a wattmeter of Hartmann & Braun, in which these requirements are said to be very exactly fulfilled. The article is concluded by some remarks on the measurements of power in three-phase circuits. He suggests giving up the term phase e. m. f. (phasenspannung) which is often used in Germany, and to use instead the clear terms delta e. m. f. or star e. m. f.—*Elek. Zeit.*, April 17, 24.

Dettmar.—A communication referring to the last point of Goerner, concerning the terminology for three-phase e. m. fs. A committee of the German Society of Elec. Eng. proposes to eliminate the term phase e. m. f. and to define star e. m. f. as the voltage between the neutral point and one of the three main circuits.—*Elek. Zeit.*, May 1.

Polarization Capacity and Dissipation of Energy of Voltameters Carrying Alternating Currents.—FRANCHETTI.—An account of measurements, made by the three ammeter method for voltameters with electrodes of lead or iron with sodium carbonate solution as electrolyte; and also for voltameters with electrodes of nickel in a solution of sodium carbonate; or nickel sulphate or potassium or sodium hydroxide. The voltameter with lead electrodes in saturated sodium carbonate solution exhibits at temperatures of 10° to 15° C., a minimum of capacity for a certain value of the effective potential difference applied to the poles, this varying, according to the formation of the voltameter, from 0.89 to 1.07 volts. The capacity per sq. cm. of electrode varies from 530 to 290 microfarads, and the angle of lead of the current before the voltage from 48 to 58 degrees, whilst the increase of resistance (*i. e.*, the energy dissipated divided by the square of the current) over the resistance of the electrolyte, has finally a value three times that of the latter. With iron electrodes, however, the resistance of the voltameter is but slightly greater than that of the electrolyte, and is almost independent of the current. Voltameters with nickel electrodes and electrodes of alkaline carbonate or hydroxides show similar behavior. For nickel electrodes in potassium hydroxide the impedance increases only to a very slight extent with the frequency, and the mean capacity during a period is inversely proportional to the frequency. The increase of resistance of a voltameter over that of the electrolyte has been attributed by Wien to spontaneous depolarization, but, in the light of the present results, the author considers the greater dissipation of energy as due partly to an increase of resistance and partly to polarization loss.—*N. Ciemento*, 1901, Nov., Dec.; abstracted in *Science Abstracts*, May.

Earth Currents.—GUARINI.—An illustrated article on earth currents and the electro-tellurograph. An account is given of experiments made by Perez del Pulgar in a Spanish observatory. The earth plates of two lightning conductors were connected to a galvanometer, in series with a very great resistance. He found that the oscillations of the galvanometer are more frequent and more intense when thick clouds pass along at a considerable speed; the variation in intensity of the sun's light seems to cause variations in the intensity of the earth currents; on damp and foggy days the needle generally points to zero; the wind very appreciably influences the intensity of earth currents, this intensity increasing in inverse proportion to the rate at which the wind travels. Notwithstanding these observations he concluded that the nature and the origin of earth currents cannot yet be explained satisfactorily. For a systematic study the automatic electro-tellurograph of Lancetta is recommended; it consists of a very sensitive galvanometer, the coils of which are connected with two different earth connections more or less distant from one another. The relay has two contacts, and, according to the direction of the earth current, works one or the other of two electromagnets which act upon a dial recording mechanism.—Lond. *Elec. Rev.*, May 16.

Vacuum Tube Apparatus.—VON CZUDNOCHOWSKY.—A description of a universal apparatus suitable for demonstrating numerous vacuum tube phenomena. The main body is a vacuum bulb with four tubes attached, the whole forming a cross. One of the tubes contains the anode, and the opposite one is the tube to be connected to the mercury pump. The two remaining tubes have wide mouths, and are intended for the reception of different cathodes and anticathodes, including plane and concave plates, hollow cathodes, after Goldstein, and wire cathodes.—*Ann. d. Phys.*, May 15; abstracted in Lond. *Elec.*, May 30.

REFERENCES.

Measurement of the Angle of Lag.—FINZI.—A communication in which he first briefly discusses the method of Hanchett of measuring the angle of lag and the power factor with a voltmeter (ELECTRICAL WORLD AND ENGINEER, Nov. 2, 1901); it is Ayrton's method of the three voltmeters; measurement of the three voltages to be determined is made with one voltmeter and a switch. Concerning Breslauer's method of measuring large phase differences, recently described in the Digest, he remarks that it can be applied to the so-called three-ampere method.—*Elek. Zeit.*, April 10.

Hot Wire Ammeter.—KOLLERT.—An article on the theory of the hot wire ammeter, with references to measurements of Hankel and Friese.—*Elek. Zeit.*, May 1.

TELEGRAPHY TELEPHONY AND SIGNALS.

REFERENCES.

Electric Waves and Wireless Telegraphy.—SEIBT.—A very long mathematical article on electric waves on wires, with special references to Marconi's wireless telegraphy. It appears to be a simple and good introduction into the mathematical theory of Hertzian waves. Steinmetz's symbolic method is made use of with great success. The intimate connection is shown between problems of wave transmission over cables and problems of wireless telegraphy. The capacity, which is considered to be a disturbing factor in cable telegraphy, becomes a very important factor in wireless telegraphy, for without it transmission to a distance would not be possible. He first gives the general analytical theory and applies the results to the explanation of several arrangements used in practice for wireless telegraphy. The paper is concluded by the description of a series of experiments which appear to be good lecture-room illustrations, and in which he reproduced Tesla's light effects in a different way. The experiments refer to the resonance of coils, the damping of waves in coils and the demonstration of the waves in coils by photographic methods.—*Elek. Zeit.*, April 10, 17, 24, May 1, 8.

Underground Telephone Wires.—ZAPPE.—A long and profusely illustrated paper, read before the Berlin Electrical Society. Since 1888 the German Post-office Department (which has a monopoly of telephone installations in Germany) has begun to put the wires underground and is continuing this every year. The methods of construction are described in detail.—*Elek. Zeit.*, April 10.

MISCELLANEOUS.

Dusseldorf Exposition.—SEYFFERTH.—A long illustrated description of the electrical exhibits at the present industrial and commercial exposition for Rhineland and Westphalia, in Dusseldorf, Germany. The generating station for lifting and power contains 29 dynamos, or, together, 7,900 kw; six are three-phase generators of 4,450 kw, and one is a single-phase alternator of 300 kw. Electric power is used for various exhibits; the exhibits of the equipments of mines are said to be especially interesting.—*Elek. Zeit.*, May 8, 15.

Directory of Electrical Societies, Etc.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Next meeting, Pittsburg, June 28 to July 3, 1902.

AMERICAN ELECTOCHEMICAL SOCIETY. Next meeting, Niagara Falls, N. Y., Sept. 15, 16 and 17, 1902.

ELECTRICAL CONTRACTOR'S ASSOCIATION OF NEW YORK. Semi-Annual meeting, Hotel Ten Eyck, Albany, N. Y., July 15, 1902. Pittsburg, June 27 and 28, 1902.

INDEPENDENT TELEPHONE ASSOCIATION OF WISCONSIN. Next meet ing, Waupaca, Wis., June 25, 26 and 27, 1902.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES. Next meeting, Philadelphia, Pa., June 24, 25 and 26, 1902.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Next meeting, Richmond, Va., Oct. 7, 8 and 9, 1902.

SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION. Next meeting, Pittsburg, June 28 to July 3, 1902.

THE AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Annual meeting, Hotel Kaaterskill, Catskill Mountains, N. Y., Sept. 2, 3 and 4, 1902.

Works and Products of the Stanley Electric Manufacturing Company—II.

(Concluded.)

TRANSFORMER building for general lighting purposes was the initial purpose of the Stanley Company and has remained one of their most important lines of manufacture. Transformers of this type are now built in sizes of 0.5 to 30-kw capacity. The standard voltages of these transformers correspond to general practice as follows:

Primary Voltage.	Secondary Voltage.
1,000 or 2,000	50 or 100
1,000 or 2,000	100 or 200
1,150 or 2,300	115 or 230
1,200 or 2,400	120 or 240

Each lighting transformer has four primary terminals on a porcelain board, and these terminals are readily connected by two clips for either of the primary voltages for which the transformer is adapted. These transformers are filled with oil when ready for operation. Iron used in transformer cases is made to a patented formula owned by the Stanley Company, and is said to present a nearly constant hysteresis loss irrespective of age. A special feature of transformer windings is their separation into six or ten coils in each case according to the

FIG. 1.—ALTERNATORS IN ELECTRA POWER HOUSE.

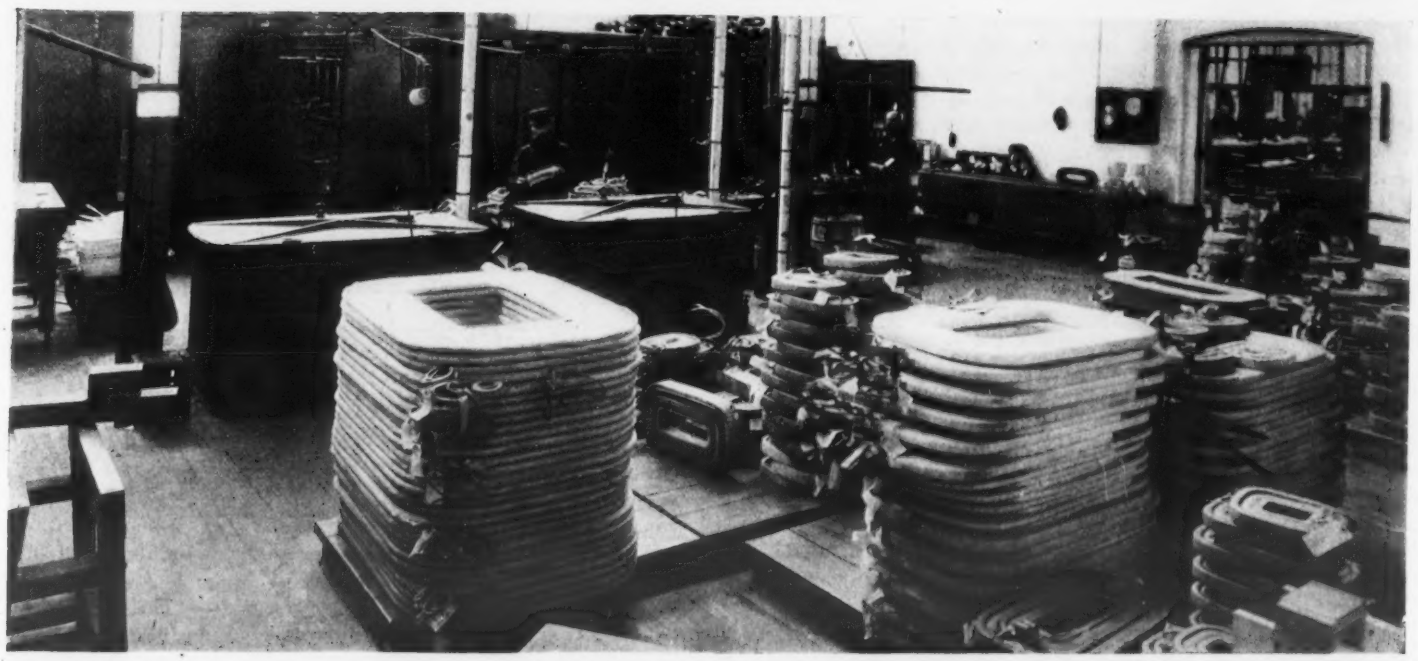


FIG. 2.—TRANSFORMER COIL WINDING DEPARTMENT.

size and the assembly of these coils. The smaller transformers contain three primary and three secondary, and the larger transformers five primary and five secondary coils. In each transformer, all of the coils are assembled into two equal groups after being completely taped.

Each group consists of three or five coils. A group of three coils contains one secondary in the center with a primary coil on either side. A group of five coils contains three primary and two secondary coils, the primary coming at the outside, center and inside of the group. By this construction a secondary is always interposed between two primary coils so that a high degree of insulation is maintained between the several primary coils, and the voltage at the terminals of any one of these coils is only a fraction of that on the line. Each lighting transformer case is insulated from its case and a test with 10,000 volts is made between core and case; coils and case, coils and core, and between primary and secondary coils.

Besides the lightning transformers just described, the Stanley Company makes a line of subway transformers, and three distinct types for use in stations. The subway transformers are intended for use in manholes with underground construction and each is provided with a cast-iron case, oil and water-tight. These subway transformers

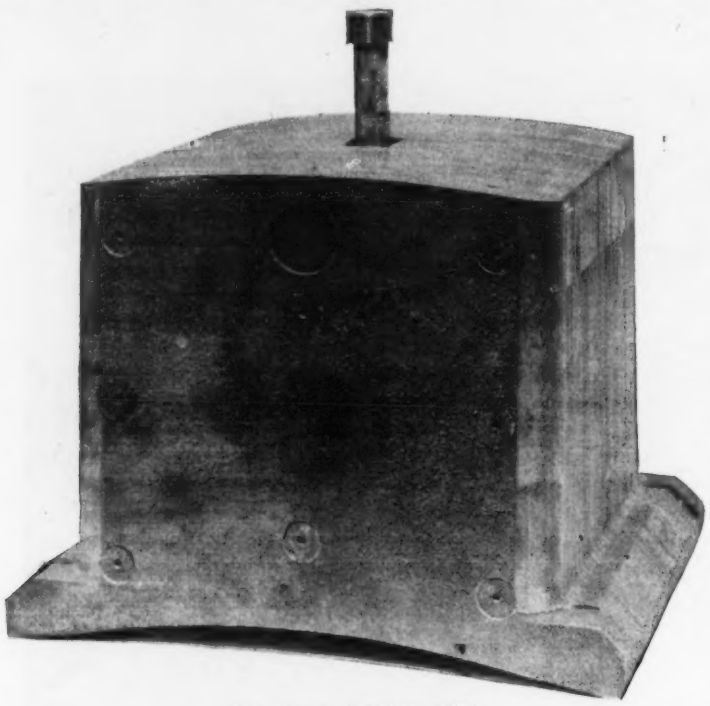


FIG. 3.—A MAGNET CORE.

are all filled and are made in sizes from 5 to 40 kw. Metal tubes make water-tight joints with the transformer case at points where primary and secondary cables enter, so that the lead coverings of these cables may be joined to the tubes by wiped joints. This type of transformer is built for any periodicity and for any pressure up to 2400 volts.

A line of indoor transformers with dry insulation and air cooled by either natural or mechanical draft is built in sizes from 10 to 75-kw and for use on any potential up to 10,000 volts at any frequency. In these transformers there are openings at the tops and bottoms of the cases, so that the cooling air passes directly over the coils and cores.

Another line of indoor transformers, oil insulated, is built in sizes from 10 to 50 kw at any pressures up to 15,000 volts.

For long-distance transmission or other service where large units, continuous service and high potentials are necessary, the Stanley Company has worked out its line of oil insulated water-cooled transformers. This series includes sizes from 35 to 500-kw for any frequency, and for any voltage up to 40,000. In the oil surrounding the core and coils of each of these transformers, is placed a coil of brass pipe intended to carry circulating water when the transformer is in operation. This circulation of water in the brass pipe may be maintained from any source of moderate pressure. Water enters the brass piping cold or at its normal outside temperature and is discharged at a higher temperature after having absorbed a quantity of heat from the oil in the transformer. The transformer temperature can be varied, as more or less water is forced through the brass coil, but enough water to lower the temperature of a transformer below that of the surrounding air should not be forced through the pipe, as this will cause the transformer to sweat. It is stated that a 150 kw transformer of this type will not rise in temperature more than 35° C. above that of the surrounding air under constant operation at full load if 0.5 gallon of water at 15°C. is forced through the brass piping.

The oil-insulated indoor transformers have a maximum rise in temperature of 40°C. above that of the surrounding air, under continuous operation at full load. Both types of oil-insulated station transformers are subject to similar insulation tests. These transformers when designed for operation at less than 5000 volts are tested with 10,000 volts between primary and secondary coils during one minute; 10,000 volts between primary coils and iron for one minute, and 10,000 volts between recording coils and iron frame for one minute. Transformers designed to work at more than 5000 volts in either set of coils are tested with double the primary voltage between primary coils and secondary coils, and between primary coils and iron, during a period of one minute. Also with the full primary voltage between secondary coils and iron during one minute.

In all of the station transformers, the primary and secondary windings are made up of a number of separate coils, each varying from four to sixteen according to capacity and voltage. As may be noted in the illustration showing piles of these coils in the winding room, each coil is very narrow compared with its diameter. This construction is produced by a comparatively large number of layers and very few turns per layer. The voltage between layers is thus kept relatively low. Primary and secondary coils are assembled on the transformer cores in alternate order so that a secondary is between two primary coils. This not only permits ample insulation, but also ensures proper interlinking of the magnetic flux with all of the coils. Coils are supported on the transformer cores by wooden blocks and wedges, and sheets of insulating material are placed between primary and secondary coils. After all the coils are in position on a transformer core, they are connected into their respective groups.

At this point it is interesting to note some of the structural details of the 700 kw transformers installed at the Colgate power-house and operated for the transmission to San Francisco, the longest in the world—220 miles.

Each of these transformers is of the oil-insulated, water-cooled type with capacity of 700 kw at 60 periods per second. These transformers step up from 2300 volts on the generator side to 34,675 volts on the line side, but have taps brought out for 23,175 and 28,925 volts.

As at first used, these transformers were connected in groups of three, delta fashion on the generator side and star fashion on the line side so as to give 40,000 volts on the line, but the permanent connection will give 60,000 volts on the line. In each of these transformers, the primary winding is divided into 16 coils and the secondary winding into 8 coils. The pressure per coil of the primary winding is thus 2167 volts. Each primary coil is composed of 73.5 turns of copper strip, one turn per layer. Each secondary or low pressure coil contains 19.5 turns of copper strip wound one turn per layer, and each layer with three strips in parallel. Two of these primary coils are mounted with a sheet of micanite betweeen them on the core, and such groups of two primary coils alternate with the secondary coils, as may be seen by inspection of the figure. These transformers were put to an insulation test of 75,000 volts between high-tension winding and core for one minute, 75,000 volts between high-tension and low-tension winding for one minute, and 37,000 volts between low tension-winding and core for one minute.

All the iron parts of these transformers are connected to earth. The efficiency and regulation given by the Stanley Company for these transformers are as follows:

EFFICIENCY.

98.6	per	cent	at	125	per	cent	load
98.5	"	"	"	100	"	"	"
98.4	"	"	"	75	"	"	"
97.8	"	"	"	50	"	"	"
96.2	"	"	"	25	"	"	"

FULL LOAD REGULATION.

100	per	cent	power	factor,	regulation	0.7	per	cent
90	"	"	"	"	"	1.9	"	"
80	"	"	"	"	"	2.4	"	"
70	"	"	"	"	"	2.6	"	"

After 24 hours' run at full load the temperature of oil in these transformers was 35° C. above that of the surrounding air.

While not confined to any one type of generator, the Stanley Company has pushed the construction of inductor alternators to a high degree of perfection. These alternators are regularly made by the company from the smallest sizes up to machines of more than 2000 kw capacity. The standard construction for these alternators includes a cast steel element of flywheel type with a circular group of

laminated poles or inductors mounted at each side of the rim. This element, composed entirely of iron and steel, revolves, and is the only moving part of the machine. Outside of the revolving inductor, comes the armature, a cast steel ring with two circles of armature punchings built up on its interior surface. Armature coils are mounted in these two circles of iron stampings, and come directly over the laminated inductors or poles on the revolving element. There are thus two independent rows of armature coils, and between these rows the single magnet coil of the inductor alternator is mounted. This coil is supported by the armature casting, and so requires no moving connections. Armature coils are usually wound two per slot and are of the concentrated type, as there are only two slots opposite each of the revolving inductors. By suitable spacing of the armature coils in these slots, currents of either two or three phase are obtained.

The single magnet coils previously mentioned are of peculiar and

FIG. 4.—50,000-VOLT OIL TRANSFORMER, WATER-COOLED.

interesting construction. Each coil is wound, usually with copper strip, in a heavy brass spool or ring. Radial depth of the winding is small compared with the diameter of the spool, and the winding is divided into two equal parts by a radial space that is left all round the spool, for the purpose of ventilation. These magnet spools and coils change but little as the capacities of generators increase, but their diameters go up rapidly. The magnet spool for the smallest inductor alternator built by the company has a diameter of 14 inches inside, 22½ inches outside, and is 4¼ inches wide. For an alternator of 1500 kw capacity at 120 r.p.m. the diameter of a magnet spool is 17 feet 11¼ inches outside and 15 feet ¼ inch inside with a face of 4¼ inches. Two of these spools are used in the 7500 kw machine.

Several sizes of these inductor alternators are employed in the long distance transmission previously mentioned and the following data relates to the largest of the lot. This generator has a capacity of 2000 kw at 2200 volts and 60 cycles, when driven at 240 r.p.m. At this speed the periphery of the inductor travels about 10,000 feet per minute. The total weight of this inductor is nearly 52,000 pounds.

Power Factor.	Regulation.
100 per cent	3 per cent
90 " "	8.2 " "
80 " "	11.0 " "
70 " "	11.4 " "

The regulation of this alternator at different power is given above. The efficiencies at different loads are:

Load.	Efficiency.
125 per cent	95.00 per cent
100 " "	94.75 " "
75 " "	93.5 " "
50 " "	92.0 " "
25 " "	89.0 " "

A no-load curve of e.m.f. for this generator very closely approaches the true sine form. For continuous operation the temperature rise above the air was 35° C., and the generator carries an overload of 50 per cent for four hours without dangerous heating.

The type of induction generators just described is especially suited for frequency changers, because there are two entirely independent groups of armature coils. These frequency changers are made by the company for any even ratio, but the standard apparatus is suited only for the ratio of two to one. As in the inductor alternator, so in the frequency changer; there is only a single magnet coil. In the latter machine, one set of armature coils acts as a motor and the other set acts as a generator. The ratio of voltage transformation in the frequency changers may be as great as ten to one, and the phase relation of the delivered currents may differ from that of the received currents. An independent voltage regulation of 10 per cent in each phase is also provided for at the frequency changer. These machines may be used to render the low frequency currents of long transmissions and of street railways available for any purpose where high frequency is required. Besides the inductor type, the Stanley Company also build a line of revolving-field alternators. The magnets

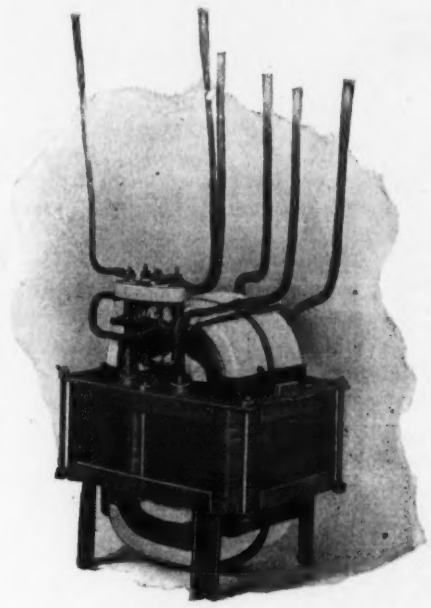


FIG. 5.—TRANSFORMER.

of these machines are built up of stamped iron sheets between end plates and are mounted on a center portion of cast steel. The magnet stampings are bound together by rods of soft steel, as shown, the cut also illustrating the method of bolting into one of these rods to attach the magnet to the circular frame of a rotary converter. These rotary converters are made in a variety of sizes to meet the usual requirements. One of the converters recently constructed was of 600 kw capacity and 600 volts on the direct-current side, at 375 r.p.m. This converter was 8-pole, 25-cycle and had an efficiency of 96 per cent at full load.

The company is now at work on a line of street railway motors ranging from 35 to 150 hp capacity. These have cast-iron frames, but the poles and magnet cores are laminated throughout.

To avoid the troubles that frequently occur with ordinary rheostats, due to overheating on long and heavy loads, a rheostat in which the resistance is built up with grids of cast iron, has recently been developed. Owing to the high melting point of cast iron, it is believed that this rheostat cannot be injured by any loads that will be applied to it.

In this hasty sketch of the main products of the Stanley Company, many kinds of auxiliary apparatus of much interest have necessarily been neglected. Prominent among these latter may be mentioned full lines of ampere, volt and watt meters, arc lamps for both direct and alternating-currents, lightning arresters, ground detectors, circuit breakers, fuses, phase indicators, and condensers.

Time Element Circuit Breaker Attachment.

By B. Parks Rucker.

The apparatus shown in the accompanying illustrations is a time element and instantaneous trip attachment for automatic circuit breakers, on which the writer has just been allowed patents. The two photographic views show this apparatus attached to a "G. E." and to a "G. I." circuit breaker, respectively, and in the drawing the same attachment applied to a "Type A" Westinghouse breaker.

Primarily, the device consists of an auxiliary weight or other resistance added to the tripping solenoid core or armature magnet, and a device for removing said weight or resistance after a predetermined overload or short-circuit. In the apparatus shown, this is accomplished by means of an independent operating circuit, which is closed by a small switch controlled by a slight movement of the tripping parts on the advent of an overload. The movement of the switch is much greater than that of the part controlling it, this being accomplished by pivoting the switch-carrying arm at a point

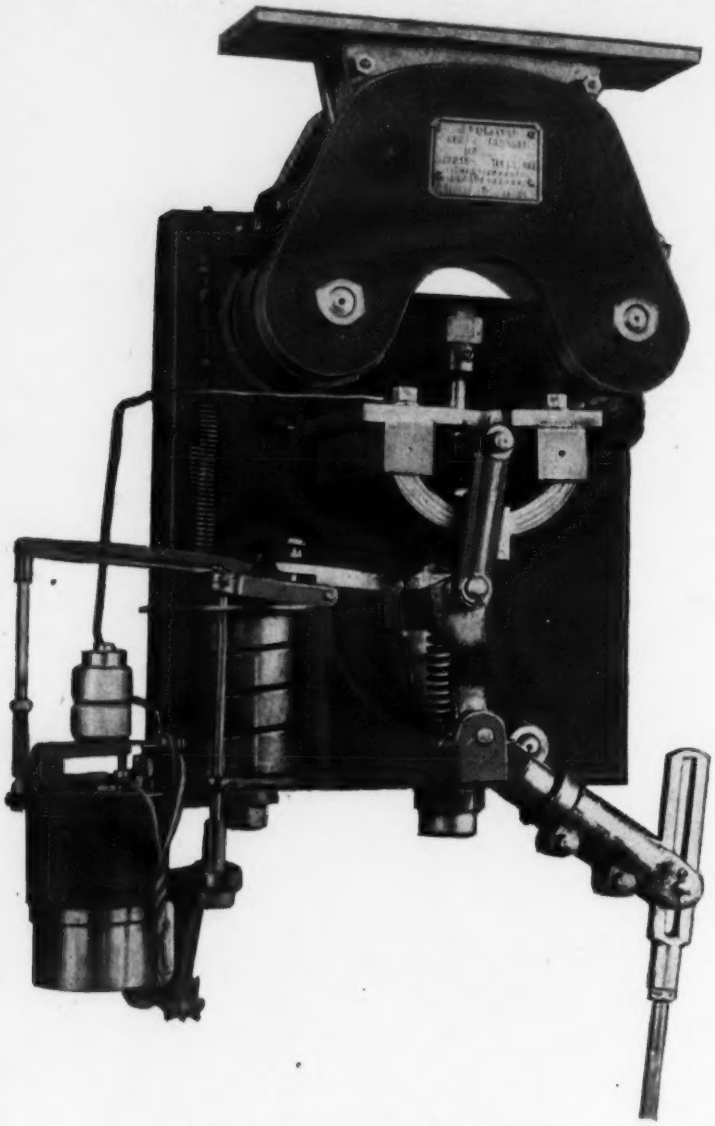


FIG. 1.—CIRCUIT BREAKER ATTACHMENT.

close to the place where the force is applied. These switches, or switch-carrying arms, also serve as a means of adding the auxiliary weights to the spring, weights, or other calibration of the breaker; and by being withdrawn from mesh with the other mechanism allow the breaker to trip at a lower rating than it otherwise would.

The operation of the apparatus is as follows: The circuit breaker used is calibrated in the usual way, and is set at the point at which it is desired to have it open the circuit with a time limit, of, say, five seconds; then the auxiliary weight is added until the point is reached at which an instantaneous break is necessary. It is seen that adding these auxiliary weights has exactly the same effect as if they were added directly to the solenoid core or magnet armature. Then if an overload, greater than the time, but less than the instantaneous calibration, comes on, the tripping device closes the circuit through the operating solenoid, and the core rises slowly, being retarded by the oil-dash pot. If the overload stays on long enough, the pin in the solenoid core raises the auxiliary weight and draws the switch-carrying arm free of the other mechanism, and the breaker is then free to open the circuit in the usual way.

Should the overload cease before the five seconds is up, the tripping

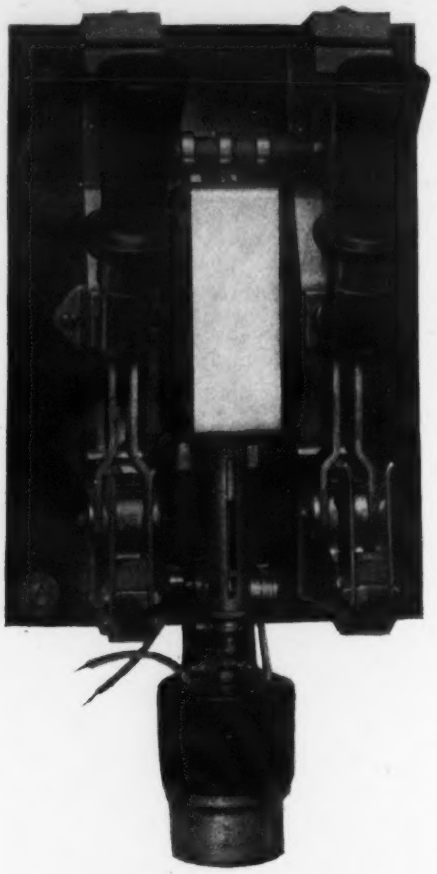


FIG. 2.—CIRCUIT BREAKER ATTACHMENT.

core falls back and the parts resume their normal positions. On the other hand, should a short-circuit or abnormal overload come on, the pull on the solenoid core or magnet armature is great enough

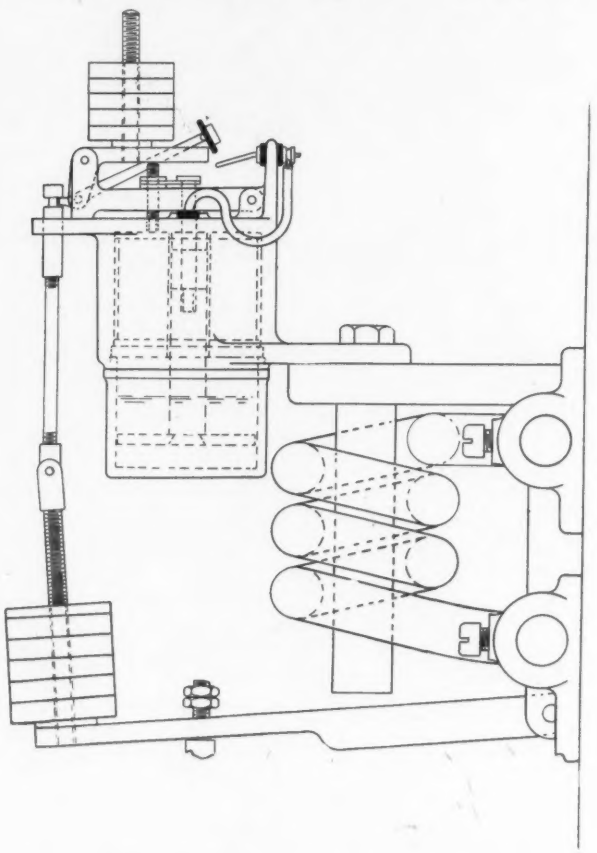


FIG. 3.—TIME ELEMENT AND INSTANTANEOUS TRIP.

to raise both weights and break the circuit instantaneously. The timeing device is calibrated by regulating the distance through which

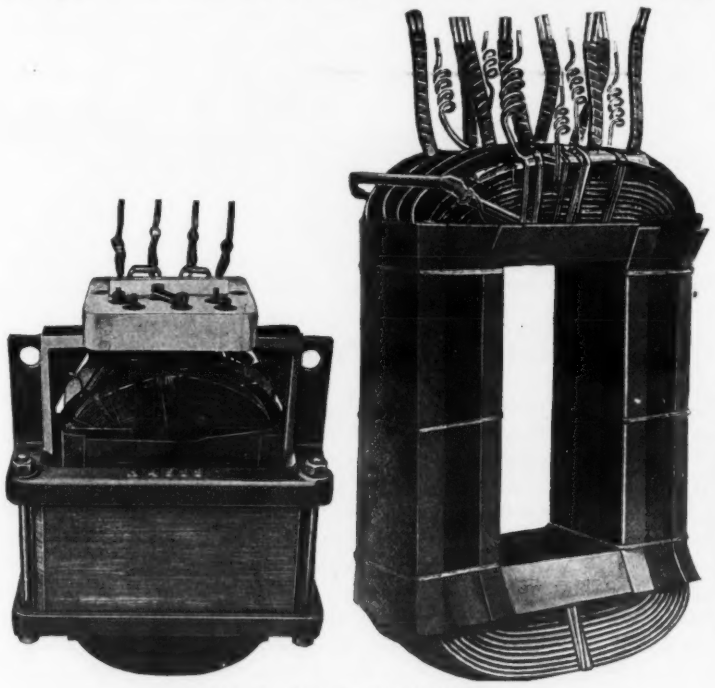
the operating solenoid core has to travel before releasing the weights, and by regulating the amount of current in the solenoid. A very light oil is used in the dash-pot to prevent any possibility of sticking, and the piston fits loosely in the cylinder, thus allowing the oil to flow around the edges instead of through valves.

The "G. E." apparatus shown has been in operation for over two months on a 550-volt railway panel, and has been put through a very severe test. The breaker formerly had a habit of opening about twice in three days, and was set at 1,200 amperes. After installing the time limiting device the instantaneous break was raised to about 1,500 amperes, and the time limit set to break the circuit in four seconds with the current above the 1,000-ampere limit. In the first six weeks the breaker opened three times—twice instantaneously on short circuits, and once on time; the conditions were exactly the same in both cases. A tell-tale, placed in series with the operating solenoid, showed that the breaker starts to open as often as before, but the periods of overload are so short that the apparatus does not have time to work.

A scheme of this kind should be valuable wherever the current flow is subject to fluctuation, as for instance, at railway panels, on street car breakers, elevators, cranes, printing presses, motors, and, in fact, wherever an automatic overload circuit breaker is used. The same apparatus, with slight modification, can be used on alternating current breakers, oil switches, etc.

New Westinghouse Transformer.

As the Westinghouse Company was the first to introduce the practice of winding for two primary and two secondary voltages, it is not surprising that this company has taken another step forward in the same direction by bringing out a transformer provided with additional voltages. The new transformer, known as "Type N," is not intended to replace the company's well-known "O. D." transformer, but rather to fill the demand for one which, provided with additional ratios of transformation has a greatly extended range of voltage. The shell type of canstruction is used. The primary winding is divided into equal parts, which may be connected in series or in multiple. The secondary winding is divided into four equal parts,



FIGS. 1 AND 2.—TRANSFORMER.

which may be connected in series, series-multiple, or multiple. The primaries of all transformers are wound nominally for 1000 and 2000 volts. Transformers from ½ to 25 kw inclusive are wound for nominal secondary voltages of 50, 100 and 200, and those from 2 to 50 kw, inclusive, for voltages of 100, 200 and 400. The secondary voltages in each class of transformers can be varied to suit either the varying line voltages of an extensive transmission system, or to give special voltages from standard circuits. All transformers are arranged for three-wire secondary distribution, and the secondary coils cross-connected to give equal voltages on both circuits, even with large unbalanced loads.

Telpherage Plant in Cuba.

In these modern exporting days, no American device or invention ought to be considered to enjoy full recognition until it has been tried abroad as well as at home. Thus the telpherage system, which after so many earlier years of tribulation and failure, has at last been worked out to a successful issue in the United States, and is now exemplified in so many useful plants for handling material, may be regarded as having received the final seal of approval from its adoption outside this country. What we believe to

FIG. 1.—TELPHER LINE CROSSING THE RIVER.

be the first foreign telpherage plant is that here illustrated, having been built and put in operation by the United Telpherage Company, of New York City, for a concern in Cuba.

It was necessary to handle limestone in a region where tropical rains frequently caused the rivers to rise to such an extent that bridges were swept away, and where it would not pay to maintain a construction equal to every flood, if indeed it were possible to do so. In such a situation it was easy to prove the advantages of telpherage, and in Figs. 1 and 2 we show the style of construction adopted for the line. The telpherage circuits are held by the G-shaped brackets, and are carried on wooden "A" supports, with

FIG. 2.—TELPHER LINE ACROSS COUNTRY.

200 feet span between the supports in some places, as at the ford, although they are in general spaced 100 feet along the line. There is, as will be noted, a double track, with solid steel curves, and the little telphers make a speed of 15 miles an hour, each with its load of limestone. Four trains are in use, and with the telphers it is easy to add a train of trailers. In this case a load of 1,200 pounds is transported usually per train. There are eight curves, and a grade of 5 per cent. is attained. Fig. 3 illustrates the form of loop terminal adopted at each end of the line, so that an endless procession of the skips can be kept up, and the loading and unloading proceeded with at a high rate of speed. In fact, the capacity of telpher

lines to get away with material runs up into extraordinarily large figures, for while the load of any individual telpher may be relatively

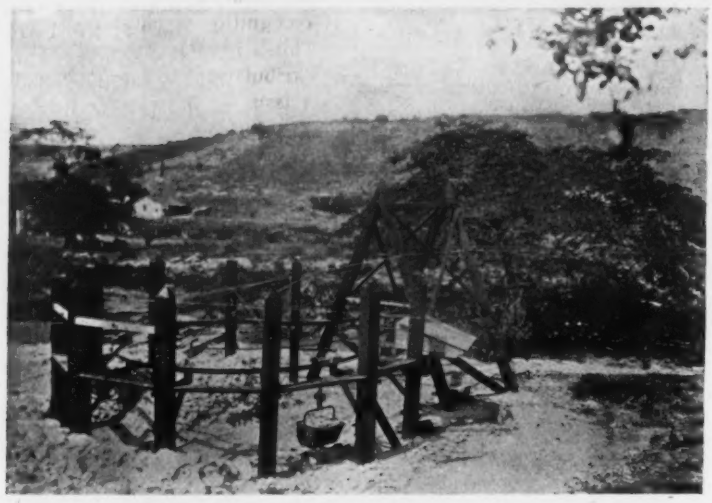
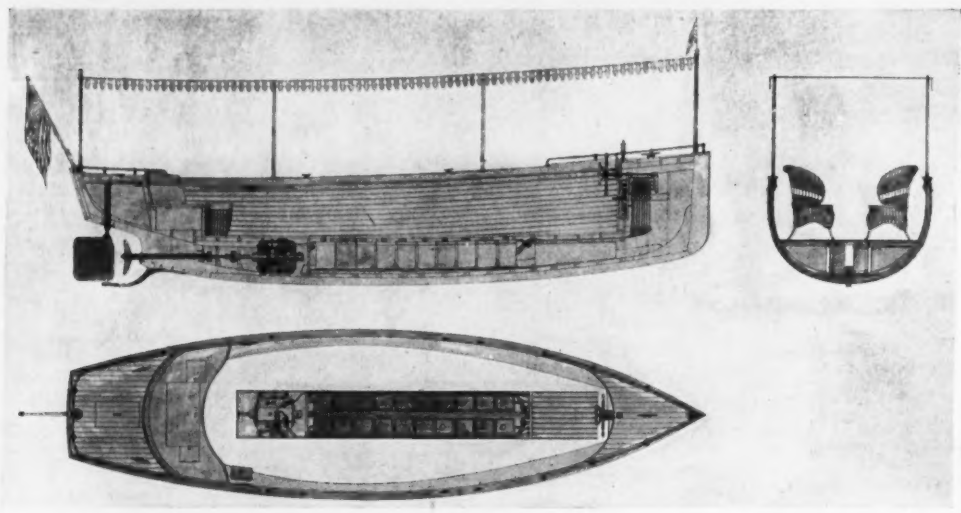


FIG. 3.—TERMINAL STATION FOR LOOP.

small, the succession is at the shortest intervals and can be made virtually incessant. This condition suits tropical work admirably in many ways, and we shall not be surprised to learn that telpherage has found many of its best customers in tropical countries.



SECTIONS AND PLAN OF ELECTRIC LAUNCH.

Electric Launch "Koola."

The Electric Launch Company, of Bayonne, N. J., has recently supplied an electric launch of special design, for use on Tuxedo Lake. The hull is built of mahogany throughout, with a long cockpit on level floor for accommodating easy wicker chairs, as shown in the accompanying illustration. There is room in the cockpit to accommodate five chairs and a table comfortably, which, with the divan seat, enables the owner to carry six or seven guests.

The length over all is 21 feet; beam, 5 feet 6 inches; draught, 24 inches. It is fitted with a 2½-hp electric motor, with storage battery capacity enabling the launch to cover a distance of 40 miles on one charge. The highest speed of the launch is seven miles an hour. The motive apparatus, including batteries and motor, is placed below the flooring of the boat, thereby increasing the stability of the craft.

Power for refilling the batteries, when exhausted, is obtained from the electric lighting plant at Tuxedo. One man, usually the gardener about the place, is all that is necessary to charge and care for the launch. The launch is usually operated by the owner, Mr. Richard Delafield, and is named "Koola." Mr. Delafield expects to use this launch for fishing and pleasure purposes, and has a special attachment whereby both control of power and steering of boat is obtained at two distinct points, at the fore and aft ends of the cockpit of the boat, respectively. For fishing, the lowest speed, 2½ miles, is used, which makes an excellent trolling speed, and with less noise than in the case of a row-boat with muffled oars.

As the water at Tuxedo Lake is used for drinking purposes by the residents of the Park, the community has been strongly opposed to all power launches on the lake; row-boats and sail-boats have only been in use for a number of years. Upon carefully investigating the power of an electric launch, Mr. Delafield came to the decision that there was absolutely nothing pertaining to the power apparatus of the launch that could in any way contaminate the water of the lake. He, therefore, placed an order early in the winter for a boat to be specially built to meet his requirements. The outboard shaft bearing is lubricated by the water which surrounds it, and, therefore, no oil or grease is used on any part of the apparatus. A recent improvement enables electric motors to be operated at 1,00 r. p. m. without the use of any oil on the bearings, and this type of motor is installed in the launch at Tuxedo.

Direct-Current Ceiling Fans.

The ceiling fan, illustrated herewith, is manufactured by the Sterling Electric Motor Company, Dayton, Ohio. The fan is stated to have minimum mechanical, electrical and magnetic resistance, which insures a cool-running machine. The armature is built up with laminated disks. The fan may be operated on 500-volt circuits. The bearings, commutator, switch, brushes, etc., have been designed for efficient service over the most lengthy period. The speed regulating rheostat, which is made of fire-proof material, is separate from the fan mechanism, by reason of which the heat of the rheostat is kept away from the windings, insulation and bearings of the motor. This, it is claimed, is a distinct advantage in the operation of the fan.

CEILING FAN.

The Sterling Company makes only this one type of ceiling fan for the standard voltages, and in the various fittings and finishes.

Conduit Rods for Underground Work.

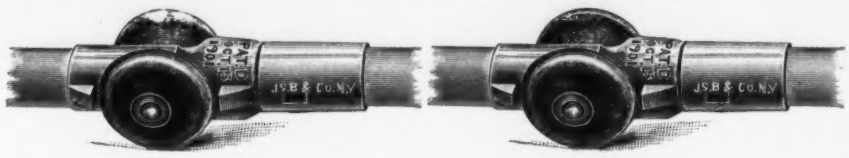
A number of essential details are connected with the use and operation of underground conduits, and among the most important in the line of conduits come the rods for pushing through the ducts. We illustrate herewith the Villard automatic-wheeled conduit rods, which have been found very effective for their purpose. They have been evolved by a practical conduit workman, from an experience of several years, during which he rodded several millions of feet. These rods possess the good qualities of the solid joint, and have, in addition thereto, the advantages of being quickly connected and disconnected, and of being easily pushed or drawn through the ducts.

Attempts have been made in the past to replace the threaded or pipe-coupling rods with others which could be more easily and quickly connected, but defects were usually found, which prevented their coming into practical use. In using rods with joints that were easily detached heretofore, a loose joint would cause the rods to buckle when they were pushed through the ducts, and, under the strain, a zigzag line was formed, which destroyed the alignment, and, in consequence, the ends of the rods were pressed against the sides of the conduit. This caused considerable friction, making it necessary sometimes to employ the combined strength of several men to manipulate the rods. These disadvantages have, it is said, been eliminated in the Villard automatic-wheeled rod. The rods are very light running, owing to their being provided with wheels. In

their construction, special provision is made for their becoming rigid when they are pushed through the conduits, and flexible when they are pulled, thus allowing a considerable variance when crossing a man-hole, and making it easy to take another duct out of line with the first; the rods becoming again rigid when pushed into the new conduit on the opposite side. It is a physical impossibility for the rods to become uncoupled while in the conduits, owing to the fact that a 3-ft. rod has to be raised 20 inches, or to an angle of about 45 degrees before it can be separated.

The Villard automatic-wheeled conduit rods are made of very hard bronze couplings, the wheels being of chilled cast-iron, and the rods of first-class seasoned hickory soaked in oil. The soaking prevents their absorption of moisture, and thereby prolongs the life of the wood. The rods are fastened securely in the ferrules, with a wedge at the inner end, which enables them to stand more tension than they would if they were fastened by the ordinary riveting.

The wheels on the conduit rods save friction and wear on the rods themselves, enabling one man to push with ease a set of 200 rods or 600 feet. The ordinary section length averages, approximately, 400 feet, thus making rodding light work. They also serve as duct cleaners; each pair of wheels bringing out a quantity of dry dirt or mud as they are removed from the conduit or passed through a man-hole, leaving the duct comparatively clean. In removing obstructions, a very hard blow can be struck with telling effect with these rods without the slightest injury to the rods. The wheels also act as a guide to the rods, causing them to take a bend or curve as great as 2½ feet in 12. The wheels insure a 2½-in. duct opening through the entire section length, thus allowing a cable of that dimension to be installed without any danger from obstructions.



CONDUIT ROD.

The average day's work of four men with the old style of screw rods is 3,000 to 4,000 feet, while with these Villard automatic-wheeled rods the average day's rodding of two men is said to be from 8,000 to 10,000 feet. On one occasion two men did 20,915 feet of rodding in eight hours.

These rods are made in hickory, 3 ft. to 4½ ft. long, and of ⅞-in. and 1-in. diameter, and of iron pipe when desired, instead of hickory. James S. Barron & Co., 200 to 206 West Broadway, New York, who are sole agents, and who are selling these rods strictly on their merits, will send a full set of 200 (600 feet) on ten days' trial, upon application of any company contemplating purchasing rods.

Regulating Incandescent Lamp.

A new incandescent regulating lamp has recently been patented by Miller & Burrows, of Chesaning, Mich. The lamp fits standard sockets without the intervention of special attachments, and is claimed to be so simple in construction as to insure the minimum of cost in manufacture and the maximum of durability, while equal to others in economy of consumption. The lamp has two filaments. To reduce the candle-power the filaments are connected in series by means of a simple switch attached to the bulb, and so placed as to be easy of access.

A Selective Party-Line Telephone System.

At the present cost of line construction the only possible way of giving a very cheap telephone service to the "occasional user" is by means of the so-called "party-line," where several instruments are connected on the same circuit; but the annoyance occasioned by the frequent ringing of the bells, the difficulty of recognizing the proper signal and the lack of privacy often render this class of service unsatisfactory. It has always been recognized that a selective-signalling system for party lines, which should lock out subscribers not wanted and warn such subscribers that the line was in use, was greatly to be desired. The requirements are that such a system should not need instruments complicated in construction, or liable to get out of order. It should be adapted to any style of telephone and should not require more line wires than the usual metallic circuit. It should be applicable to the usual switchboard, and not require special skill on the part of the operator, nor extra labor on the part of the subscribers.

The Maybury-Holmes Selective System, now being put on the market, aims to fulfil all the above requirements, and to meet objections now existing in the party-line telephone, giving practically as good service as if such instruments had an exclusive line to the exchange.

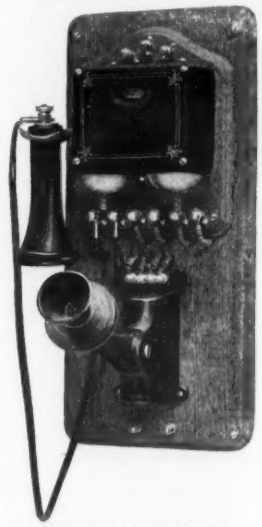
The subscriber by removing his receiver signals "central," and at the same time locks out all instruments on his line, displaying a "busy" signal at locked-out stations. When central signals the subscriber, she rings only the bell at the station required, and also locks out all other stations on that line. When two subscribers are in communication, there is no possibility of their conversation being interrupted or overheard by other subscribers connected to the line. It is arranged with complete double supervision, so that as each receiver is hung up at the close of conversation, the clearing-out signals are displayed in the central office. The operator on receiving clearing-out signal restores the instruments on both lines to zero, and removes plugs. If she neglects to properly restore the lines, the line signal will be immediately displayed upon removal of the plugs, and can be only replaced by restoring the instruments to their normal conditions. Intercommunication is possible to parties on the same line, but only through the co-operation of the central office.

An automatic key is provided, the switchboard consisting of a series of push-butons, numbered to correspond to the number of instruments on any one circuit, and all that is necessary for the operator to do in signalling the desired subscriber is to push in the button corresponding to the subscriber wanted, and to press her ringing-key in the usual manner. This selects the subscriber wanted automatically, and rings the bell at that station only. Only one automatic key is required for each operator's position, no matter how many party-lines may be assigned to her.

This system has been given a thorough trial, and is now in successful operation in regular exchange service. To Mr. F. E. Maybury, West Medford, Mass., who is interested in the development of this system, we are indebted for the above data.

Lineman's Torch.

We illustrate on this page a lineman's torch, made by the Clayton & Lambert Manufacturing Company, of Detroit, Mich. It is a pint size. The tank is drawn out of heavy brass, free from seams, and all the fittings are heavy. Reinforcements are used to make the tank extra strong. A brass air pump of the latest design forms part of the handle. The burner produces a strong, blue flame, consuming very little gasoline. Improved double-shouldered needles are used, making very durable burners. By referring to the cut, it will be seen that the burner is mounted on a swivel joint, so that the flame can be thrown in any direction. it is thoroughly well made, and, though strong, is still light, well balanced, easy to handle and always ready for use. Clayton & Lambert Manufacturing Company will be glad to send fuller description and price to any reader of the ELECTRICAL WORLD AND ENGINEER upon receipt of their request.



SELECTIVE PARTY-LINE TELEPHONE.

TORCH.

Popular Telephone Outfits.

A new departure is being made in the line of popular telephone apparatus by the Atwater-Kent Manufacturing Works, of 116 North Seventh Street, Philadelphia, who are placing on the market a complete telephone outfit, packed in a box, ready for installation. The chief feature in this set is their new "monoplex" telephone, which has received a hearty welcome as a low-priced piece of apparatus. Ordinarily a man putting up a private telephone line has to think of, and buy separately, every piece of necessary auxiliary apparatus, and to haunt an electrical or a hardware store. Out of this state of affairs has arisen the plan of the concern named, to put up all the parts of a system in a box. The outfit consists of the monoplex telephone, two dry batteries, one pound of No. 18 annunciator wire, one box of double-pointed tacks or staples, 8 backboard screws, and all put up with directions for installing. The motto is "Every man his own telephonist," for there are innumerable places where a telephone line can be installed to advantage without any idea of exchange service. An illustration of the "Monoplex" telephone was shown in a recent issue of ELECTRICAL WORLD AND ENGINEER.

St. Louis World's Fair Subway.

An interesting piece of work is being pushed vigorously to its completion, and is monopolizing the attention of a large force of workmen on the World's Fair site, St. Louis. This is the subway which is to contain all the electric wires of the distribution system.

The contract for constructing this subway was let some two months ago, at which time some intimation was given of the extent of the work. Visitors to the site find that in passing from one part of the grounds to another their way leads many times over deep excavations, spanned by broad planks.

Along the entire length of this tunnel workmen are employed boxing in the sides and bottom, and installing a series of shelves on either side. This work is rapidly reaching its completion, will be over one mile long when complete, extending from a point near the government building, along the entire length of one of the transverse avenues of the exposition, following the direction of the

MAIN ELECTRICAL SUBWAY, ST. LOUIS FAIR.

River des Peres channelway and terminating at the Electricity Building, where the Westinghouse Company will install a complete electrical plant, furnishing a large percentage of the power for running the exposition. After the "trunk lines" of the wires have been conducted along the shelves of the subway, it will be covered with earth, as all the other series of underground ways are being treated, and subsidiary wires connecting with the main wires will be conducted to every part of the grounds.

The system will be one of the most intricate pieces of work in connection with the exposition. This electrcal subway is 7 feet wide by 7 feet deep. It will be 1 foot beneath the surface of the earth when the final grading has been done and the whole surface of the exposition valley has assumed the level of a floor.

As it passes through parts of the grounds which are still in the form of hills and dales, the cut which has been made is in places fully 40 feet deep.

Westinghouse Equipment for Mersey Tunnel

The last of the main Westinghouse generators and engines intended to be installed in the power plant of the Mersey Tunnel Railway are about to be shipped from the Westinghouse works, at East Pittsburg. These generators are of railway type, 1,200-kw, 650-volts, 90 r. p. m. They will be direct connected to vertical cross-compound engines of 1,500 hp each. The power-house lighting and the electric light of all stations, sidings, etc., will be supplied from a separate generating plant. Two compound-wound generators, each having a capacity of 200 kw at 650 volts, direct connected to Westinghouse compound engines, are to be installed for this purpose. The speed will be 250 r. p. m. The Westinghouse electro-pneumatic system of train control is to be used. The Mersey Tunnel Railway, which joins Liverpool and Birkenhead, was formely a steam road. It is about 4½ miles in length, and is principally laid in a double-track, brick-work tunnel, the total track length being 12 miles. The change to electric motive power, made by the British Westinghouse Electric and Manufacturing Company, Limited, is attracting considerable attention in railway and electrical engineering circles in Great Britain.

The rolling stock will consist of 60 cars. The trains will be formed of five cars each. No locomotives will be used; the first and last cars of a train will be motor cars, each equipped with four 100-hp motors. The contract with the British Westinghouse Company stipulates that they shall guarantee the interest on the existing four and half per cent., redeemable, first debenture stock, amounting to £249,276, and that they shall provide for the repayment of the stock at par not later than June 30, 1904. The price to be paid to the Westinghouse company is £635,303, payable as to £620,000 in new four per cent. first perpetual debenture stock, and £15,303 in cash. Thus, allowing for the retirement of the existing four and a half per cent. first debenture stock, the Westinghouse company will receive a net sum of about £386,000. The railway, operated under steam, has shown an average deficit for the last five years of over £33,000. The enormous traffic between Birkenhead and Liverpool—last year about 9,000,000 passengers by steam road, and nearly 23,000,000 by ferry boat—will, it is expected, result in the new electric line being placed among the most important in the world. The £20 stock of the Mersey Railway Company, which last year was quoted not higher than £1, and as low as 5 shillings, was listed last week at no less than £14. The contract with the Westinghouse Company calls for completion of the system by January 15, 1903.

Electric Lighting in Sydney, Australia.

The Municipal Council of Sydney, New South Wales, Australia, has decided to install an electric lighting system in Sydney, and through its consulting engineers, Messrs. Preece & Cardew, of London, England, has asked for tenders on furnishing the complete station and substation machinery.

The plan as laid out by Messrs. Preece & Cardew, and accepted by the council, is as follows:

Main Station.—The central station is to be located in the center of the city on Darling Harbor, a short distance from the new power-house now being built by the General Electric Company, for the city tramway system. The location affords excellent water-front facilities, and is convenient to the Government railway, thus enabling a siding to be run from the railway to the power-house for carrying coal and ashes. The intention is to run the siding up an incline, so that the coal can be dumped directly into the coal bin, thus doing away with coal handling machinery. Similarly the ashes will be loaded directly into the cars.

The boiler room will contain five water-tube boilers, each one capable of evaporating 10,000 lbs. of water per hour, the temperature of the feed water being 200° F. These boilers are to be provided with mechanical stokers and all of the most modern appliances. A separate superheater, capable of superheating the steam 100° F., is to be provided and located between two of the boilers. Three Green economizers, each consisting of 576 tubes, and provided with scrapers, etc., are to be used, as well as two feed pumps of the vertical type.

The engine room is to contain two 600-kw units and one 300-kw unit, each consisting of steam engines and electric generators. The generators are to be wound to deliver three-phase alternating current at a voltage of 5,200, and at a frequency which has not been

absolutely decided upon, but which will be between 40 and 60 cycles. The engines are to be provided with surface condensers, and the air and circulating pumps are to be electrically driven by means of three-phase induction motors, operating at 415 volts.

Each unit is to be provided with a 125-volt exciter, whose armature is placed directly on an extension of the main engine shaft, and thus forms a part of each unit.

In addition to these exciters, an auxiliary storage battery of a capacity of 1,500 ampere-hours, is to be provided, to be used for lighting the station and as a reserve in case of trouble with the exciters. This battery will be charged by a motor generator set, consisting of a 415-volt three-phase induction motor, direct connected on one end of its shaft to a 125-volt direct-current generator, and on the other end to a booster.

The necessary switchboards are to be provided, and the station is laid out with a view to ultimately enlarging it to 25,000 hp.

Substations.—Six substations are already planned, two to be located in the central part of the city, and arranged for direct-current distribution on the three-wire system at 240 volts between neutral and each outside wire. These stations are to be provided with motor generating sets, each set consisting of a 150-kw three-phase induction motor, wound for 5,000 volts and direct connected to two 75-kw, 240-volt direct-current generators, one connected to each end of its shaft.

The other four substations will be situated in the suburbs and be provided with static transformers for distributing on the four-wire, three-phase system. The three transformers will be Y-connected, and will be wound to transform a voltage of 5,000 down to 240. All of the transformers are to be oil-cooled, and are to be built in sizes from 10 kw up to 50 kw. The necessary high-tension and low-tension switchboards, for controlling the substation apparatus, is to be provided for each substation.

A system of mains and feeders will be laid out, and we believe the American "pulling-in" system will be used and not the "solid-laid," as common in English cities. A sufficient number of ducts will be laid in the streets to provide for future use; 220-volt arc lamps will be used for street illumination, and the Council intends to do private lighting where such business can be obtained, all of this lighting being done at a voltage of 220.

The city is now mainly lighted by gas, although there are one or two small private electric lighting companies, whose business is mainly the lighting of stores and theatres in the business section of Sydney. These the Council will have to compete with, but as they do not wish to make money, but simply to pay running expenses they should have no trouble. Within 18 months, if all goes well, Sydney will have the finest electric lighting plant in Australia, and should be as well and as cheaply lighted as any city in the world.

Telephone Cable Fittings.

The New Haven Novelty Machine Company, New Haven, Conn., is placing on the market a line of telephone cable fittings designed to supersede the wiped joint. Since the advent of the telephone many hundreds of patents have been taken out for electrical devices pertaining to the art, but to the equally essential side, the mechanical, it is claimed that minor attention has been given, and particularly with respect to jointing. The present method of connecting lead covered electric cables is by means of plumbers' wiped joint, probably because constructing engineers as a class know of no other. Aside from the initial cost of a wiped joint there are other factors that should be considered; for example, having plumbers always at hand when wanted; when the joint is wiped that it will never leak; the cost of a leaky joint, not only in finding its location, but when found, the cost of repair. This latter cost is apt to be more than the original cost of wiping the joint. No two constructing engineers agree on what the cost of a wiped joint is, how much time it takes, or how much solder used. Moreover, no consideration is usually taken of the difference in the cost between wiping a joint in the shop, in the manhole or on a cable suspended from a telephone pole; yet these are important factors.

The New Haven Machine Company claims to have produced a successful substitute for a wiped joint, which is moisture proof, simple of construction, and does not require skilled labor, whch can not only be applied quickly, but gives liberty of inspection without extra cost, as often as desired, thereby adding a flexibility which the wiped joint does not possess; moreover, it is also economical and purely mechanical. It is claimed that this substitute not only fills these requirements, but has been thoroughly and successfully in practical use.

We illustrate herewith the "Novelty" slidable sleeve for telephonic cable connection. The essential features are as follows: The slidable sleeve allows inspection at any time and as often as required to disconnect and reconnect requiring but a wrench and a few minutes' labor. The sleeve is attached to the cables by means of a joint which allows the solder to flow down by its own gravity, and gives a longer

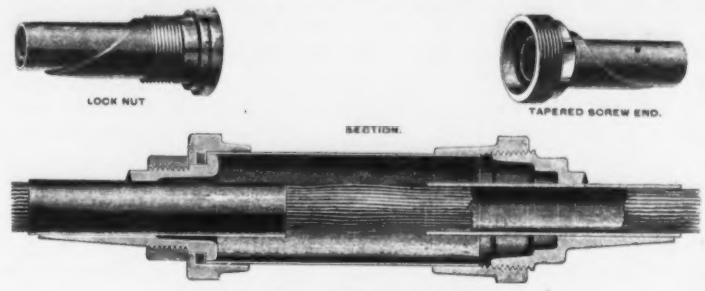


FIG. 1.—SLIDABLE SLEEVE.

supporting surface to the cable than the wiped joint, making it stronger and requiring no skilled labor. To make the sleeve moisture proof, a lock nut on one end is compressed against a soft metal ring, and on the other end a tapered thread screw is employed the same as used by the pipe fitters.

Fig. 1 shows a Novelty slidable sleeve, consisting of a brass shell with hubs attached to each end, the latter tinned and ready for soldering; the lock nut is also shown. To apply this joint the taper screwed end is passed over the cable, then the rest of the sleeve is slipped on the opposite end of the cable. The wires are next spliced as usual,

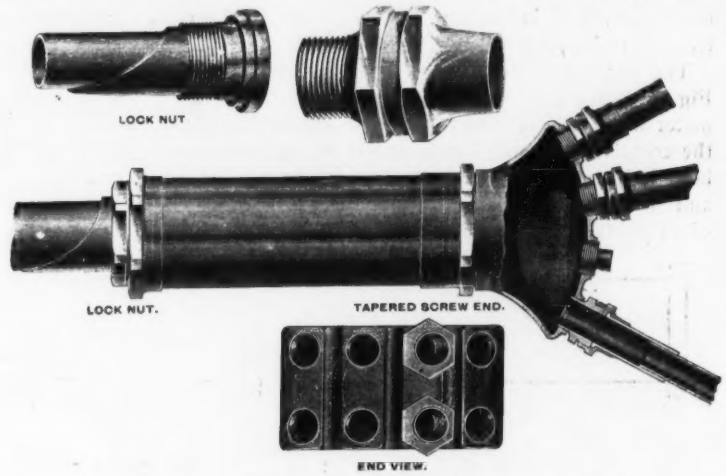


FIG. 2.—TERMINAL HEAD.

after which the tapered sleeves are placed centrally on the cable and the outside sleeve joints soldered to the lead covering of the cables.

Fig. 2 shows a terminal head and fittings, with eight branches. To apply the head the sleeve is slipped on the cable and the tinned outside end is soldered as above. The sleeve is then screwed into the head, red lead being used on the thread. After the cables are placed in place, the sleeve is slipped back and the splice made. The Y branch is practically covered by the above description, but its cheapness over the old method will particularly appeal to all users of lead covered electric cables. The pot-head consists merely of two pieces, the brass shell, and the nut with solder encased; to join the same with the cable requires only a hot iron to cause the solder to flow, and dispenses with the necessity of binding the cable to wipe the joint as at present.

Plant for Tremont Temple, Boston.

A new engine and dynamo will be installed in Tremont Temple Building, Boston, as an indirect result of a difference between the consolidated electric light companies and the Temple management. The addition will also provide for the heating of the building and the operation of elevators as at present. The new installation will cost about $3,000, and will operate about 1,000 incandescent lamps, being rated at about 50 kw; that number of lamps being virtually the requirement of regular Sunday evening services in the large hall. The two old engines will carry about 900 lamps, but will be called

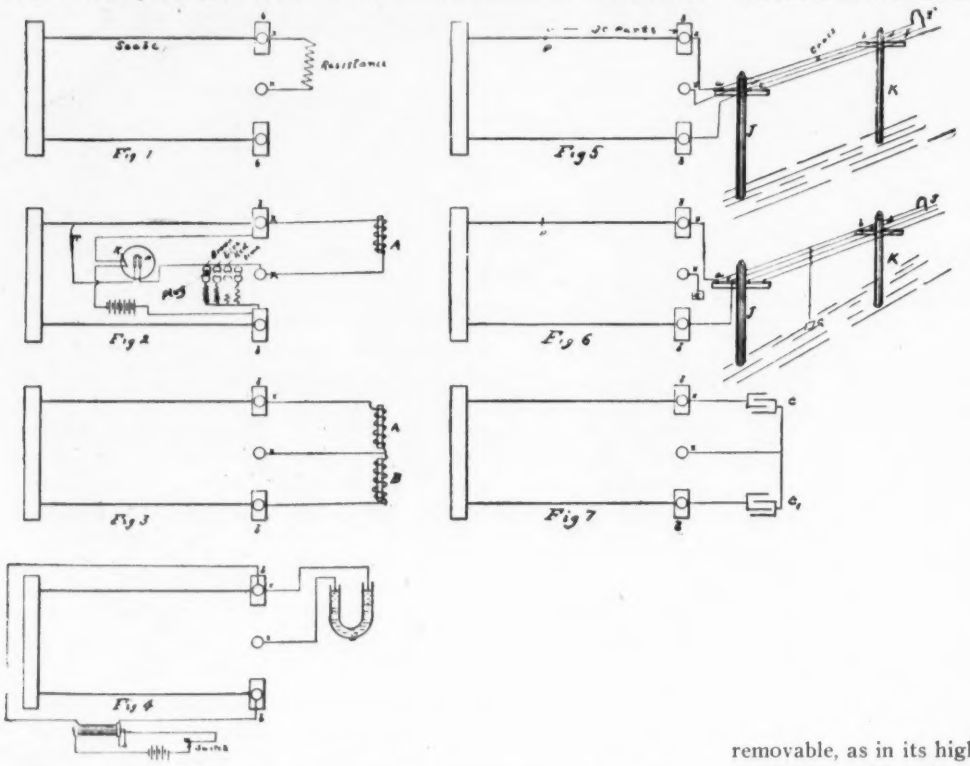
into use only in case of a break-down, or when the entire building has to be lighted. Under the previous arrangement, the Temple ran about half its lights with its two engines and bought from the outside companies the extra current required for evenings when all its halls and meeting rooms were in use. The cost of the extra light was about $40 per month. The Temple management decided to install another unit rather than take all its current from outside at a cost of $200 per month, and an outlay for new elevator machinery of about $7,000.

The new unit will be composed of an 86-hp Ames engine, direct connected to a 50-kw Westinghouse generator. The engine is of the usual type found in isolated plants, being single cylinder, 12 in. x 12 in., non-condensing, automatic cut-off, operating at 90 lbs. steam pressure per square inch. The generator is designed to give 110 volts direct current at 275 r. p. m. Both engine and generator, together with others in the plant, are located 30 feet below the Tremont Street sidewalk. All the generators in the plant are connected on the inverted three-wire system, the wires from the positive brushes of the machines going to positive bus-bars forming the outers, and the negative brushes being connected together on the middle bus used as a common return of larger cross-section.

The Sage Ohmmeter.

It is probably not generally appreciated that the well-known Sage ohmmeter type of instrument can be used for making many tests which are not within the range of an ordinary Wheatstone bridge. They are so nearly absolutely non-inductive that it is feasible to use alternating current instead of battery power without introducing any appreciable error, and this, of course, enables such work as measurement of inductance and capacity and the resistance of electrolytes to be accomplished.

The accompanying figures show various methods of connection. Fig. 1 shows how an ordinary resistance is connected to the ohmmeter when it is desired to measure its value in ohms. Fig. 2 shows the complete scheme of connections of the ohmmeter. Fig. 3 shows how inductances are compared, *A* being the unknown inductance, and *B* a coil whose inductance is known. Fig. 4 how the resistance of an electrolyte is measured. It will be noted that this is connected



FIGS. 1 TO 7.—DIAGRAMS OF METHODS OF CONNECTING OHMMETER.

in the same way that an ordinary resistance is attached, but that the alternating current obtained from the secondary of an induction coil is used instead of the direct current ordinarily furnished by the batteries contained in the instrument. Fig. 5 shows how crosses on lines may be determined by the ordinary loop test, and Fig. 6 the location of grounds in a similar way. In Fig. 7 are shown the connections for measuring capacity, *C'* being a standard condensor, and *C* the unknown capacity. In this case, as in Fig. 4, an alternating current is employed in place of the direct current.

The length of the scale of the ohmmeter on which the resistances are read off is 30 inches. As the scale of an ordinary portable volt

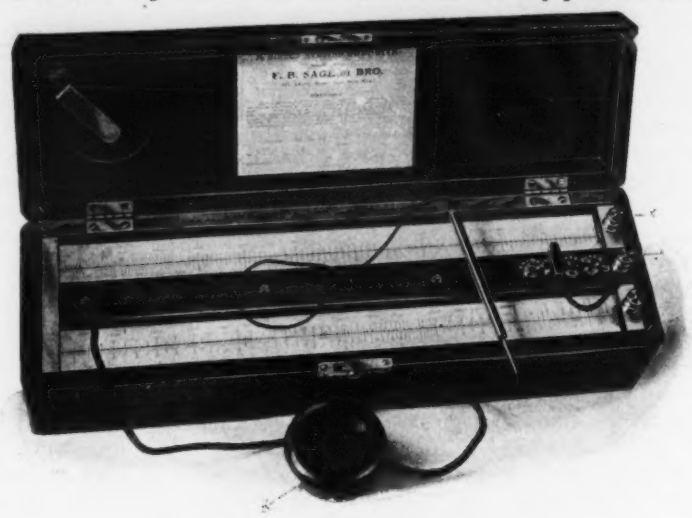


FIG. 8.—OHMMETER.

or ammeter is but 5 inches long, some idea can be had of the fineness of readings obtainable. The instrument itself is illustrated in Fig. 8.

Messrs. Machado & Roller, of 203 Broadway, New York, the general selling agents for the Whitney Electrical Instrument Company, have arranged for the exclusive manufacturing and selling rights for these interesting devices.

A New Telephone Receiver.

The demand for a somewhat cheaper receiver than has usually been furnished by the big exchanges, has led the Kellogg Switchboard & Supply Company, of Chicago, to produce a new instrument, illustrated herewith. It is made in composition shells. The tailpiece is not made

TELEPHONE RECEIVER.

removable, as in its highest grade receivers, but a cord can be readily repaired by taking the working parts out of the receiver after removing four small screws. The company states that it has always been opposed to the substitution of any imitation of hard rubber for use in receiver shells, and heretofore has refused to furnish receivers with this kind of shell. It has, however, claimed to have secured a good composition which it is willing to guarantee in all respects. The material has the external appearance of hard rubber in its glossy blackness, and is said to retain this appearance almost indefinitely.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Money hardened somewhat during the week, the closing rates for 60 days to six months' time being 4½@5 per cent., according to collateral. In the stock market, dullness at the close of the week followed increasing activity, with advances in standard railroad stocks. On the whole there was a general improvement in prices, although it was evident that the speculative public had little to do with the market. The coal strike did not cause any particular irregularity in any of the stocks directly or indirectly affected thereby. The United States Steel shares declined on account of injunction suits against the proposed bond issue and retirement of a part of the preferred stock; the industrials were generally neglected, and Amalgamated Copper was dull. The tractions and electrics were generally firm with upward tendencies. Of the former class, Brooklyn Rapid Transit made a net gain of ¼ point, closing at 67⅛, the sales for the week aggregating 11,675 shares. Met. St. Ry. closed at 150¾, being a net gain of 2 points, the total sales being 3,395 shares. General Electric closed at 313 asked, being a net loss of 6¾ points, the highest point of the week being 320 and the lowest 311. Westinghouse common suffered a net loss of 4 points while the 1st pfd. made a net gain of 6 points, the closing figures being 210 and 214¼, ex. div., respectively. Western Union closed at 91¾, a net gain of 1½ points; Am. Tel. & Tel. 174⅛, a net gain of 1⅛, and Amer. Dist. Tel. 36, a net loss of 2 points. Following are the closing prices of June 17:

NEW YORK.

	June 10.	June 17.		June 10.	June 17.
American Tel. & Cable..	87	—	Gen. Carriage (n. st'k).	4⅝	4¾
American Tel. & Tel....	174½	177¼	Hudson River Tel.....	103	104
American Dist. Tel.....	35½	—	Metropolitan St. Ry....	149	151⅜
Brooklyn Rapid Transit.	67¼	67⅛	N. E. Elec. Veh. Trns.	—	—
Commercial Cable	160	—	N. Y. E. V. T. Co....	13	13
Electric Boat	30	28	N. Y. & N. J. Tel.....	166	166
Electric Boat pfd.....	45	40	Tel. & Tel Co. of Am..	—	—
Electric Lead Reduc'n..	2¾	2¾	Western Union Tel....	90¾	92
Electric Vehcile	6½	6½	West. E. & M. Co....	211½	—
Electric Vehicle pfd	13½	13	West. E. & M. Co. pfd.	210	217
General Electric	317½	305			

BOSTON.

	June 10.	Holiday.		June 10.	Holiday.
American Tel. & Tel....	174	—	Mexican Telephone	2¼	—
Cumberland Telephone..	—	—	New Eng. Telephone ...	149	—
Edison Elec. Illum.....	—	—	Westinghouse Elec	—	—
Erie Telephone	—	—	Westinghouse Elec. pfd.	—	—
General Electric pfd....	—	—			

PHILADELPHIA.

	June 10.	June 17.		June 10.	June 17.
American Railways	45¼	45½	Phila. Traction	97¼	98
Elec. Storage Battery ..	88	90	Phil. Electric	5⅛	5⅜
Elec. Storage Bat'y pfd.	88	90	Pa. Elec. Vehicle	1¼	1¼
Elec. Co. of America....	7¼	7¼	Pa. Elec. Vehicle pfd...	3	3

CHICAGO.

	June 10.	June 17.		June 10.	June 17.
Central Union Tel.....	87½	90	National Carbon pfd....	94	95
Chicago Edison	—	179	Northwest Elev. com...	37¼	36⅝
Chicago City Ry.....	210	207¾	Union Traction	18½	18¼
Chicago Teleph. Co.....	—	170	Union Traction pfd	52½	52½
National Carbon	24¼	24½			

TOLEDO RAILWAYS AND LIGHT.—The Toledo Railways and Light Company, with a capital stock of $12,000,000, has passed into the control of interests represented by Kean, Van Cortlandt & Co., New York. With the transfer of the control of this company the famous Everett-Moore syndicate, which controlled the principal street railway systems in Northern Ohio and Southern Michigan, and has been in liquidation for several months, loses control of one of the most important systems in its combination. The Toledo Railways and Light Company controls the street railway system and the electric lighting plant of the city of Toledo. It was organized in July, 1901, and soon thereafter purchased all of the property, rights, and franchises of the Toledo Traction Company and the Toledo Consolidated Electric Company, which consisted of all the street railways and public electric lighting business in the city of Toledo, Ohio. The railway lines of the company consist of 102 miles of standard gauge track, averaging over 75 pounds per yard, and extending through all the principal streets in Toledo. The Toledo Railways and Light Company has a bonded indebtedness of $12,000,000, of which $4,000,000 is outstanding, $6,000,000 is reserved for underlying bonds, and $2,000,000 is reserved for betterments and improvements. The net earnings for the year ended Dec. 31 last, after deduction of taxes, were $674,677. The surplus, after interest payments, was $220,677, or about 2 per cent. on the capital stock. The gross earnings for the four months ended April 30 showed an increase of $46,823, and net earnings an increase of $15,288 over the previous year.

UTICA, N. Y., LIGHTING MORTGAGE.—A first mortgage of $1,000,000 has been executed and filed by the Equitable Gas and Electric Company, of Utica, N. Y., in favor of the Central Trust Company, of New York, as trustee, upon all its property rights and franchises, to secure the payment of 5 per cent., 40-year gold bonds of the said corporation, to the amount of $1,000,000. The gas company covenants and agrees that out of the total issue of bonds, $1,000,000, there shall be retained in the hands of the trustee $150,000 par value thereof, which shall be held by the trustee for the purpose of retiring an issue of 6 per cent., 20-year gold bonds secured by a mortgage given by the Utica Electric and Gas Company to the Central Trust Company, of New York, as trustee, for $150,000. The gas company further agrees that $100,000 par value of said issue shall not be authenticated until the company has deposited with the trustee the sum of $97,500 in cash, which shall be retained in the hands of the trustee to be paid to the company or upon its order only upon the completion of the electric light plant now in process of construction by the gas company.

U. S. TELEPHONE CO.—The bankers' committee in charge of the affairs of the Everett-Moore syndicate has given an option to a party of independent telephone capitalists on the United States Telephone Company, with the result that the latter, it is said, will soon be reorganized and fully financed. The United States is the independent long-distance company operated in connection with the Federal Telephone Company. Its lines now connect with nearly all the cities and towns in Ohio, and are being rapidly extended into adjoining States. Ultimately these lines, it is understood, will be connected with the independent long-distance companies in the East. Connection with Chicago and other Western cities, it is said, will also be made, and a through service between the East and West established. It is announced that a large portion of the stock in the reorganized company has already been underwritten. The United States Telephone Company is capitalized at $2,000,000. Under the reorganization plan, it is proposed to retire the floating indebtedness of the company at once.

N. Y. DISTRICT TELEGRAPH.—An examination of the books of the American District Telegraph Company by expert accountants shows, it is reported, a shortage of between $15,000 and $20,000, according to a statement made by a director of the company. An examination of books, usually undertaken after the resignation of a treasurer, was commenced some time ago. Soon afterward some differences from the usual methods of bookkeeping were discovered which, when followed up, disclosed a discrepancy, which may be only a technical one, or which may be an actual shortage. Mr. Chas. S. Shivler, for twenty-two years past secretary and treasurer, etc., of the company has been arrested and has confessed that his peculations have been going on since 1895. He had a salary of $3,000 a year.

GENERAL ELECTRIC NEW STOCK.—Stockholders of the General Electric Co. are in receipt of a circular notice regarding the recent declaration of 66⅔ per cent. stock dividend, which is made payable July 15 to stock of record June 25. Scrip will be issued in place of certificates for fractional shares, no dividends to be paid on the scrip or fractional shares until the scrip has been exchanged and certificates for whole shares issued in lieu thereof. The Farmers' Loan and Trust Co., of New York, and the American Loan and Trust Co., Boston, on and after July 15, will deliver the certificates and scrip specified. The above transfer agents will buy or sell fractional shares at the market price of the stock at the time when any order may be received.

CHICAGO ELEVATED.—Directors of the Metropolitan Elevated have sold to the First National Bank $1,500,000 4 per cent. extension bonds. The issue is being put out to meet the cost of construction of new electric branches. The price realized is not disclosed, but is understood to be about 93½ with interest.

GREENSBORO, N. C.—According to Greensboro, N. C., dispatches a deal involving the consolidation of all gas, electric light, street railway, and power interests of that city has been consummated, by which control has passed from Baltimore interests into the hands of New York parties.

WESTERN UNION EARNINGS.—The statement of the Western Union Telegraph Company for the quarter ended June 30, partly estimated, was made public last week. It compares with the actual figures for the corresponding quarter of last year as follows, 1902 being estimated for the quarter.

	1902	1901	Increase
Net revenue	$1,850,000	$1,762,436	$87,564
Interest on bonds	254,770	239,040	15,730
Balance	$1,595,230	$1,523,396	$71,834
Dividend	1,217,010	1,217,005	5
Surplus	$378,220	306,391	$71,829
Previous surplus	10,330,306	9,012,895	1,317,411
Total surplus	$10,708,526	$9,319,286	$1,389,240

*Estimated.

The fiscal year's figures (partly estimated this year and actual in the year previous) are as follows:

	1902	1901	Increase
Net revenue	$7,249,852	$6,685,248	$564,604
Interest and bonds	992,580	956,160	36,420
Balance	$6,257,272	$5,729,088	$528,184
Dividends	4,868,033	4,868,007	26
Surplus	$1,389,239	$861,081	$528,158
Previous surplus	9,319,286	8,458,205	861,081
Total surplus	$10,708,525	$9,319,286	$1,389,239

METROPOLITAN BONDS.—Messrs. Kuhn, Loeb & Co., who financiered the Metropolitan Securities Company, underwriting $30,000,000 of that company's stock when it undertook to supply the Metropolitan Street Railway Company with $23,000,000 in cash as part of the consideration of the lease, have just purchased from the Metropolitan Securities Company $12,400,000 of the Metropolitan Street Railway Company's bonds. As in the underwriting of the $30,000,000 of the Securities Company's stock, Messrs. Kuhn, Loeb & Co. formed a small syndicate among their friends to underwrite the bonds, it is not known whether the bonds will be offered to the public; or if so, at what price. It is expected they will be exceedingly popular. There were only $65,000,000 of them altogether, and they will ultimately become the first and only mortgage on the property of the Metropolitan Street Railway Company. They are 4 per cent. bonds and they run for one hundred years.

AUTOMATIC TRAIN-CONTROLLER COMPANY.—The Automatic Train-Controller Company is a recent incorporation under the laws of New Jersey to exploit a patented invention to prevent railroad accidents. The company's prospectus calls attention to the fact that 85 per cent. of the country's railroad mileage is absolutely without any system of signal protection, and that the subject of controlling trains automatically is now receiving attention in government and legislative quarters. The company is capitalized at $1,000,000, all common stock, par $10, the first allotment of which is being offered at $5 per share. The officers are: J. L. McLean, of J. L. McLean & Co., bankers and brokers, president; C. A. Shea, treasurer, and H. A. Herr, secretary. A complete working model of the invention may be seen at the company's office, 25 Broad Street, New York.

AMERICAN BICYCLE.—The American Bicycle Co. is now absolutely controlled by Col. A. A. Pope and John D. Rockefeller. Mr. Pope recently had some serious differences with the old management, sold his holdings and resigned from the presidency. Since then, however, he has repurchased his stock, and he and John D. Rockefeller now own a majority of the outstanding stock. A majority of the common stock was purchased in the stock market between $6 and $9 per share. John D. Rockefeller has become interested in the company during the past five months. In the near future the management will undergo a change, and Col. A. A. Pope will again be placed in charge of the company's affairs. Automobile business will be a notable feature.

GOLD CAR HEATING & LIGHTING.—The Gold Car Heating and Lighting Company, which has just been incorporated under the laws of the State of New York with a capital of $1,000,000, has purchased outright the entire business of the Gold Car Heating Company of New York, Chicago, and London, and also the entire business of the Gold Street Car Heating Company. Edward E. Gold, of New York City, has been elected President of the new company and made Chairman of the Executive Committee. The business has been one of the most successful of its kind and has enjoyed a large measure of prosperity.

DIVIDENDS.—The directors of the Hall Signal Co. have declared a quarterly dividend of 1½ per cent. This is an increase of ½ per cent. over the previous regular rate. A dividend of $1 a share has been declared on the Hestonville, Mantua & Fairmount Ry. common stock and $1.50 on the preferred stock. New York Metropolitan directors have declared the regular quarterly dividend of 1¾ per cent., payable July 15. The Commercial Cable Company has declared a quarterly dividend of 1¾ per cent., payable July 1.

BOSTON EDISON.—The Massachusetts Gas Commissioners have authorized the Edison Electric Illuminating Co., of Boston, to issue 16,500 new shares at $200 per share.

ROCHESTER, N. Y.—Word comes by way of Philadelphia that Stone & Webster, of Boston, have been making inquiries in Rochester, with the view of acquiring the Rochester Gas & Electric Company, which has absorbed all the heating and lighting companies of that city, and also the Rochester Railway, with the view of combining the properties, as is being done in New Orleans.

LOUISVILLE TROLLEYS.—The Louisville Railway will receive $300,000 of new 44-foot electric cars by July 1, and will put them into service at once. The company is gradually introducing modern equipment, and will spend $400,000 in improvements this year. The business of the company was never so good, earnings gaining an average of $10,000 a month and likely to go to $1,750,000 for the year, against $1,620,000 last year.

Commercial Intelligence.

THE WEEK IN TRADE.—The effect of the anthracite coal strike has widened, and distributive trade of a larger area has been touched by its influence. Good crop prospects, on the other hand, give much hope for future business. Generally, the outlook is favorable, and confidence in fall trade is evidently growing. "Export business, notably manufactured goods, is certainly improving," says *Bradstreet's*, "and cotton goods and copper, mineral oils and lumber are all moving freely." The demand for the cruder forms of iron continues undiminished, while finished products are quite active notwithstanding the quieting influences of the season. Building activity is impaired except where labor troubles interfere. Pig iron, steel rails, structural material and, in fact, all of the heavier kinds are as active as ever. In all 650,000 tons of rails are reported sold ahead for next year's delivery. Railway gross earnings for the month of May aggregate $54,143,739, a gain of 9.3 per cent over the same month last year. The granger roads report the heaviest ratio of increase, 15 per cent., while the Pacific coast roads are second on a gain of 14.5 per cent., and the southern lines third with an increase of 11.6 per cent. From the latter percentage gains range down to 3.3 per cent., reported by the southwestern railroads. The business failures during the week, as reported by Bradstreet's, aggregated 165, as against 153 the week previous and 188 the same week last year. Copper was easier during the week at an average price of 12½c.

BUENOS AYRES HORSE ROAD TO BE CONVERTED.—The Buenos Ayres Grand National Tramways Company, Limited, a British capitalized concern, which operates about 50 miles of horse tramways, employing nearly 300 cars, in the City of Buenos Ayres, Argentine Republic, is about to be electrically converted, according to private advices just received from South America. Mr. J. Hamden Wall, the general manager of the company, is now on his way to London for the purpose of conferring with his directors on the subject. The consulting engineers of the company are Sir George Bruce and White, London. The company's head offices are at 6 Eastcheap, London, E. C.

WESTINGHOUSE ENGINES AND GENERATORS.—The Woonsocket Machine & Electric Company, of Woonsocket, R. I., has placed a contract with Westinghouse, Church, Kerr & Company, calling for the shipment of two 20x40x48 horizontal cross compound condensing Westinghouse-Corliss engines and the same number of direct current Westinghouse street railway generators of 750 kw. capacity each. This contract was secured by the Boston office of the Westinghouse interests.

PLANT FOR PITTSBURG BUILDING.—The Westinghouse Electric & Mfg. Company has received a contract for the electric lighting plant to be installed in the 24-story Farmers' Deposit Bank Building on the corner of Fifth Avenue and Wood Street, Pittsburg. The Phoenix Iron Works, Meadville, Pa., have received the contract for a 400-hp engine for this plant.

NATIONAL TUBE PLANT.—A 400-hp direct-connected outfit, consisting of engine, built by the Ball Engine Company, Erie, Pa., direct connected to Westinghouse alternator, will be installed at the National Tube Company's works, Middletown, Pa.

EXPORTS OF ELECTRICAL MATERIALS.—The following are the eports of electrical materials and machinery from the port of New York for the week ended June 7: Antwerp—17 pkgs. material, $1,193. British East Indies—27 pkgs. material, $1,009; 2 pkgs. machinery, $50. Berlin—2 pkgs. material, $40. Brazil—59 pkgs. material, $2,830. Bremen—4 pkgs. material, $222. British Poss. in Africa—246 pkgs. material, $6,943. Brussels—16 pkgs. machinery, $750. Barcelona—3 pkgs. material, $100. Bilboa—2 pkgs. material, $85. British West Indies—33 pkgs. material, $805. Bournemouth—4 pkgs. material, $228. Central America—5 pkgs. material, $41. Copenhagen—4 pkgs. machinery, $391. Chili—9 pkgs. material, $175. Christiana—5 pkgs. machinery, $1,023. Frankfort—1 pkg. machinery, $50. Glasgow—52 pkgs. machinery, $2,800; 1 pkg. material, $32. Genoa—2 pkgs. material, $20. Gibraltar—1 pkg. machinery, $39. Hong Kong—1 pkg. material, $70. Hamburg—11 pkgs. machinery, $5,159; 14 pkgs. material, $807. Havre—31 pkgs. material, $648; 1 pkg. machinery, $60. Japan—3 pkgs. material, $1,250. Liverpool—399 pkgs. machinery, $19,744; 17 pkgs. material, $529. London—223 pkgs. machinery, $18,668; 75 pkgs. material, $4,025. Mexico—20 pkgs. material, $321; 14 pkgs. machinery, $2,003. Manchester—11 pkgs. machinery, $1,040; 114 pkgs. material, $9,277. Peru—3 pkgs. material, $294. Portsmouth—4 pkgs. material, $298. Reval—17 pkgs. machinery, $420. Southampton—4 pkgs. material, $211. Trieste—4 pkgs. machinery, $90; 4 pkgs. machinery, $700. U. S. Colombia—128 pkgs. material, $2,043. Vienna—2 pkgs. machinery, $75. The following are the exports of electrical materials and machinery for the week ended June 14: Antwerp—20 pkgs. material, $933; 1 pkg. machinery, $200. Argentine Republic—4 pkgs. machinery, $1,620; 54 pkgs. material, $665. Amsterdam—1 pkg. material, $65. Azores—3 pkgs. material, $250. Athens—6 pkgs. material, $250. Barcelona—17 pkgs. machinery, $413. Berlin—2 pkgs. material, $45. Bremen—2 pkgs. material, $50. British East Indies—12 pkgs. machinery, $2,137; 49 pkgs. material, $1,094. British Guiana—49 pkgs. material, $741. Brazil—76 pkgs. material, $5,868; 12 pkgs. machinery, $951. Bergen—4 pkgs. machinery, $645. British Australia—83 pkgs. machinery, $6,575; 83 pkgs. material, $2,387. Cuba—2 pkgs. machinery, $468; 49 pkgs. material, $2,504. Central America—25 pkgs. machinery, $557. Copenhagen—8 pkgs. machinery, $521. Chili—15 pkgs. material, $410. Danish East Indies—1 pkg. machinery, $25. Danish West Indies—2 pkgs. machinery, $11. Dutch West Indies—7 pkgs. material, $64. Egypt—42 pkgs. material, $650. Gibraltar—1 pkg. material, $27. Genoa—5 pkgs. material, $253. Glasgow—12 pkgs. material, $795; 3 pkgs. machinery, $335. Gijon—4 pkgs. material, $135. Hamburg—31 pkgs. material, $1,291. Hong Kong—8 pkgs. material, $308. Havre—3 pkgs. machinery, $140; 30 pkgs. material, $580. Japan—3 pkgs. material, $115. Lisbon—77 pkgs. material, $2,733; 2 pkgs. machinery, $342. London—24 pkgs. machinery, $12,718; 245 pkgs. goods, $13,662. Leicester—2 pkgs. material, $186. Liverpool—477 pkgs. machinery, $37,975; 247 pkgs. material, $5,112. Malmo—1 pkg. machinery, $269. Mexico—327 pkgs. material, $6,009; 12 pkgs. machinery, $1,005. Milan—1 pkg. material, $50. Marseilles—25 pkgs. material, $115. Naples—11 pkgs. machinery, $750. New Zealand—71 pkgs. machinery, $3,500; 171 pkgs. material, $1,031. Oporto—32 pkgs. machinery, $5,065. Peru—13 pkgs. material, $1,107. Portsmouth—4 pkgs. material, $304. Philippines—81 pkgs. material, $3,112. Riga—13 pkgs. material, $500. San Domingo—30 pkgs. material, $350. Southampton—6 pkgs. material, $141; 86 pkgs. machinery, $7,680. Stockholm—1 pkg. machinery, $103; 1 pkg. material, $435. Siam—24 pkgs. material, $2,677. U. S. Colombia—2 pkgs. material, $43. Venezuela—91 pkgs. material, $1,592. Warrington—10 pkgs. material, $252.

SALES OF ALLIS-CHALMERS ENGINES.—We give below a partial list of Allis-Chalmers engine sales for May, 1902. Wolf River Paper Co., Shawano, Wis., one 18 in.x36 in., one 22 in.x48 in. Southern Cotton Oil Co., New York City., one 14 in.x36 in., four 18 in.x42 in. Surrey Lumber Co., Baltimore, Md., 26 in.x48 in. S. P. Brown & Co., Albany, Ga., 16 in.x42 in. Devoe & Raynolds Co., Chicago, Ill., 22 in.x42 in. Carnegie Steel Co., Pittsburg, Pa., five pair vertical cross compound blowing engines, steam cylinders 46 in. and 86 in.x60 in., air cylinders, 84 in. and 84 in.x60 in. Rapid Transit Subway Construction Co., New York City, two combined vertical and horizontal Reynolds Corliss engines, cylinders, 42 in. and 86 in.x60 in. Union Steel Co., Pittsburg, Pa., three 26 in.x52 in.x48 in. horizontal cross compound direct coupled Reynolds Corliss engines. Willis Coal & Mining Co., Murphysboro, Ill., 18 in.x42 in. Gunther Foundry Machine & Supply Co., San Antonio, Tex., 16 in.x36 in. Buffalo Union Furnace Co., Buffalo, N. Y., vertical long crosshead blowing engine, steam cylinder 42 in.x60 in. air cylinder 84 in.x60 in. Studebaker Bros. Mfg. Co., South Bend, Ind., 22 in.x42 in. cross compound direct coupled Reynolds Corliss engine. Colorado Milling & Elevator Co., for Monte Vista Mill, Colo., 14 in.x36 in. Great Western Gold Co., Calif., one 14 in.x36 in. Park City Sampling Mills, Utah, one 16 in.x36 in.

THE OTIS ELEVATOR COMPANY announces the recent closing of contracts for more than fifty electric passenger elevators in New York and vicinity, forty-five of which will be installed in New York City proper. Further recent contracts cover installations for elevators to be installed in Yokohama, Japan, Melbourne, Australia, and Buenos Ayres, South America. Within the past week three large contracts have been closed for Otis standard hydraulic elevator plants in large office buildings, covering a total of 24 installations, as follows: The twenty-four story office building being erected for the Farmers' Deposit National Bank, of Pittsburg, Messrs. Alden & Harlow, architects, and the George A. Fuller Company, contractors, will be equipped with ten high speed hydraulic passenger elevators and several small elevators for freight and special service. The twenty-story office building being erected for the Corn Exchange National Bank at 15-19 William Street, New York City, Messrs. Robertson & Potter, architects, and John Downey, contractor, will be equipped with nine high speed hydraulic passenger elevators. The twenty story office building being erected for Messrs. Kuhn, Loeb & Company, at 54 William Street, New York City, Mr. James B. Baker, architect, and the Thompson-Starrett Company, contractors, will be equipped with five high speed hydraulic passenger elevators.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY of Chicago has recently closed a contract with the Northern Construction Company for a central energy multiple switchboard for Hamilton, O., consisting of three 6-panel, 3-position sections, having a total present equipment of 960 local common battery lines and 20 toll lines. Each section will contain multiple jacks for 960 lines, making the board fully multiple. The ultimate capacity of the board is 3,000 multiple lines. Included in this contract is the main and intermediate distributing frames, power plant, 900 standard common battery wall telephones, and 100 desk sets complete.

THE BOSWORTH-HOLDING COMPANY, of Cleveland, has recently been formed by W. H. Bosworth and H. H. Holding, both well known in the machinery trade in that section, with headquarters at 26 Merwin Street. It will handle new and second-hand machine tools, dynamos, motors, engines, boilers and electrical appliances and will act as Cleveland agents for the C. & C. Electric Company, the Helios-Upton Company, the Griffith & Wedge Company, the Mansfield Engineering Company, the Gem City Boiler Company, and Thomas Carlin's Sons Company.

THE D. S. & M. MANUFACTURING CO. has been organized at Cleveland, O., to manufacture telephone hardware specialties. The active members of the firm are George S. DuPont, Z. F. Sneyd and A. C. Morse, all of whom have been identified with the Federal Telephone Company in its construction work throughout Ohio. They are fully alive to the necessities of telephone line work and their chief productions will be cable hangers and messenger hangers of new and durable design.

STEAM TURBINES FOR ROSLYN, L. I.—Westinghouse, Church, Kerr & Company have been allotted a contract for two 400 hp Westinghouse steam turbines for installation in the plant of the Roslyn Electric Light Company, of Roslyn, L. I. The order was placed by C. O. Mailloux, the electrical engineer of 76 William Street, New York, who is acting as consulting expert for the Roslyn plant.

WEST POINT, N. Y.—The plans prepared for the expenditure of between $5,000,000 and $6,000,000 on improvements to the United States Military Academy, at West Point, N. Y., include a central power station, $1,146,000; new pumping station and stand tower, $10,000; modern fuel gas plant, $60,000, and steam heating plant, $25,000.

THE JENNEY ELECTRIC MFG. CO., of Indianapolis, Ind., has recently installed its special geared linotype motors in the following well-known newspaper offices: Kansas City Journal, Pittsburg Dispatch, Portland Oregonian, Minneapolis Journal, Cincinnati Times-Star, Baltimore American, Kansas City World, St. Paul Dispatch.

WESTINGHOUSE COMPANY BUYS MEXICAN COPPER MINES.—The Westinghouse Electric & Manufacturing Company is again reported to have purchased some copper properties, this time in the State of Sonora, Mexico. The purchase price is said to have been $125,000 gold.

RAILROAD SHOP PLANT.—The Atcheson, Topeka, and Santa Fe Railroad shops at Topeka, Kan., are installing a 1200-hp. electric power plant, consisting of four Ball tandem compound self-oiling engines direct connected to General Electric generators.

General News.

THE TELEPHONE.

LOS ANGELES, CALIF.—The Sunset Telephone Company will reduce its rates in Los Angeles in the effort to meet the prospective cut of the new Home Telephone Company.

LOS ANGELES, CALIF.—The Kellogg Switchboard & Supply Company has secured the contract for the switchboard and 6000 telephones from the Home Telephone Company, Los Angeles, Calif. Included in this contract is a two-position chief operators' desk, two-position wire chiefs' desk, two-position information desk, and a one-position monitors' desk, provided with the necessary connections in and to the local board, completely wired for the present equipment. The system is to be the very latest common battery multiple relay type.

DOVER, DEL.—The National Telephone Company, of New York City, has been incorporated here with a capital of $3,000,000. The incorporators are John H. Lewis, Wm. E. Milne, of New York City, and James G. Gregg, of Morristown, N. J.

WILMINGTON, DEL.—The Delaware Long-Distance Telephone and Telegraph Company was incorporated at Dover, Del., last week, with a capital stock of $250,000. The incorporators of the concern are Jesse Slinghuerr and Carroll T. Bond of Baltimore and John G. Gray of Wilmington, Del. The purpose of the company is to construct a long-distance telegraph and telephone line in Delaware, Maryland and Pennsylvania.

ATLANTA, GA.—A receiver has been appointed for the Standard Telephone Company, of Atlanta.

COLUMBUS, GA.—By a new deal the Bell Long Distance Telephone Company will connect with the system of C. W. Moore, of Paschal, Ga., who operates long-distance lines in several counties. The Bell company will also build from Columbus to Talbotton, also to Buena Vista, thence to Plains and other points, and finally to Lumpkin, Ga.

BLISS, IDAHO.—The local telephone which connects Hagerman with Bliss, and owned by W. L. Colthorp, will be extended to Salmon Falls and Shoshone.

WAUKEGAN, ILL.—The Chicago Telephone Company will soon erect a fine new building in Waukegan.

GALESBURG, ILL.—The Galesburg Union Telephone Company has increased its capital from $100,000 to $150,000.

TROWBRIDGE, ILL.—The Trowbridge Mutual Telephone Company has been incorporated by H. C. McClory, J. C. Quinn and Bernard Wilson. Capital $1500.

QUINCY, ILL.—The Adams County Telephone Exchange at Camp Point was struck by lightning and the building and contents were destroyed by the resulting fire.

ALTON, ILL.—The Central Union Telephone Company has established an exchange at the Liberty Prairie post-office, and farmers in the vicinity are installing telephones in their residences. Rural telephone lines are becoming quite numerous in the county.

ALTON, ILL.—Manager W. W. McKee, of the Alton Exchange of the Central Union Telephone Company has completed a deal whereby all the lines of the Calhoun County Telephone Company are leased to the Central Union for a term of years. The Bell instruments will be used on the system, which connects every town and village in Calhoun County with Grafton and the outside world.

VENDOME, IND.—The Vendome Telephone Company has been incorporated with a capital stock of $2000.

EVANSVILLE, IND.—Officials of the long-distance telephone company have offered to build two lines to Evansville from Louisville, Ky., to aid the movement for a local municipal plant.

MARKLE, IND.—Citizens of this place have organized an independent telephone company with $6,000 capital stock. An exchange will be installed and connection will be made with Pleasant Grove, Center, Zanesville and Ft. Wayne.

INDIANAPOLIS, IND.—The following companies have been recently incorporated: The Uniondale Rural Telephone Company, of Uniondale; capital stock, $1,300. John Smith heads the board of directors. The Needmore Telephone Company, of Needmore; capital stock, $2,000. J. B. Fleener heads the board of directors. The Beech Valley Rural Telephone Company, of Beech Valley, Ind.; capital, $130. Martin Pearson heads the board of directors. The Steuben County Farmers' Telephone Company; capital stock, $25,000. Directors Charles Griffith, C. W. De Lancy and T. W. Teagarden.

EVANSVLLE, IND.—The project to construct, maintain and operate a municipal telephone plant in this city is a question of much contention, and the stock is not being subscribed for as readily as first supposed. At a recent meeting of the Council, to further the project, to which the citizens were invited, the business men were not very numerous nor much in evidence in the discussion. It was stated that the greater number of telephones operated, the greater would be the expense, and that time will prove that a large plant cannot be maintained and operated at a low ordinance rate. A sliding scale of charges, to be increased with the increase of connections, was declared to be a future necessity. This argument was calculated to dampen the ardor of the municipal ownership people who had been led to believe the sliding scale would be to lessen rather than increase the cost of service.

VILLISCA, IA.—The Mutual Telephone Company is building a new line from Grant to Elliott.

MITCHELLVILLE, IA.—Local people are taking steps toward the organization of a telephone company.

EMPORIA, KAN.—Frank L. Brown has bought a controlling interest in the Emporia Telephone Company. Mr. Brown has an interest in most of the independent telephone companies in the southern part of the state.

AUGUSTA, ME.—The People's Telephone and Telegraph Company has been organized for the purpose of establishing a telegraph and telephone system in Worcester, Mass., and in the territory of Oklahoma and the island of Porto Rico, with $500,000 capital stock. President, Hamilton Braman, of Boston, Mass.; treasurer, Frank E. Baldwin, of Boston, Mass.

ST. LOUIS, MO.—The St. Louis County Court has assessed the telephone and telegraph companies as follows: Pacific Mutual Telegraph Company, 27.25 miles of poles, $60 per mile; 190.75 miles of wire, $10 per mile. Western Union, 921.41 miles of poles, $60 per mile; 6,450 miles of wire, $10 per mile. Bell Telephone, 14.79 miles of poles in Kirkwood, Florissant, Ferguson and Pacific, $60 per mile; 178.91 miles of wire, $10 per mile; outside of incorporate towns, 90.28 miles of poles, $60 per mile; 395.75 miles of wire, $10 per mile. American Telephone Company, 42.63 miles of poles, $60 per mile; 230.13 miles of wire, $10 per mile. Kinloch Telephone Company, 15 miles of poles, $60 per mile; 150 miles of wire, $10 per mile.

LEWISTON, MONT.—An independent telephone company will be organized at Lewiston. Those interested are: D. G. Higler, George Butch, G. M. Stone and D. M. Crowley.

PAULDING, OHIO.—The Paulding Home Telephone Company is building a line to Latty.

COLUMBUS, OHIO.—The Spencerville (Ohio) Telephone Company has increased its capital from $20,000 to $40,000.

SOUTH CHARLESTON, OHIO.—The Madison-Clark Telephone Company is preparing to build an exchange at South Solon.

PROSPECT, OHIO.—The Citizens Telephone Company is completing its new exchange at Prospect. Lines to Waldo and Richwood will be built in the near future.

STEUBENVILLE, OHIO.—For the second time within two weeks the exchange of the Phœnix Telephone Company was damaged by fire from crossed wires. About 100 telephones were burned out.

VERMILLION, OHIO.—The Vermillion Telephone Company has been incorporated, with $25,000 capital stock, by E. L. Coen, C. C. Baumhart, R. F. Quigley, Charles McGraw and W. H. Fledderjohorm.

WARRENSVILLE, OHIO.—The recently organized Warrensville Telephone Company will have its exchange in operation within 30 days. Connection with the United States long-distance lines will be made at Randall.

SALEM, OHIO.—Negotiations are pending for the sale of the Everett-Moore interests in the Columbiana County Telephone Company to the minority stockholders. The system is one of the largest controlled by the Federal Company and it is understood the Cleveland interests are offered at $300,000.

BLACKBURN, OKLA.—The Blackburn Improvement Company, Blackburn, Okla., will install a telephone system and erect an electric light plant. The officers are: M. M. Rhodes, president; W. E. Brady, first vice-president; John Landes, second vice-president; G. H. Schultz, secretary, and Frank Landes, treasurer.

TROUT RUN, PA.—The Rohe Valley Telephone Company, Trout Run, Lycoming County, capital, $600, has been incorporated.

SHICKSINNY, PA.—The Lower Luzerne Telephone & Supply Co., of this place, has been incorporated with a capital of $7500.

BUTTONWOOD, PA.—The Jackson Telephone Company, of Buttonwood, Lycoming County, has been incorporated; capital, $12,000.

CHESTER, PA.—The Bell Telephone Company has completed its new exchange in Media. The new equipment cost about $36,000.

PHILADELPHIA, PA.—The Keystone Telephone Company hasreceivedan order from the Union Traction Company for the installation of a private system of 250 telephones.

PHILADELPHIA, PA.—The Keystone Telephone Company has over 4000 telephones in operation, and new subscribers are, it is stated, being added at the rate of 80 to 100 daily.

PARIS, TEXAS.—The Citizens Telephone Company of Paris has been incorporated with $120,000 capital stock with A. H. O'Neill, R. W. Wortham, James Bastable, Frank Bain, B. Seymour, Joseph Timmons, H. J. Runkle, J. W. Fulton, George E. Crane, D. O. Fruth, B. S. Young and C. S. Ames. All except the first two are residents of Kenton and Fostoria, Ohio. McCrady & Mitchell of Austin will build the line.

FREDERICKSBURG, VA.—The Northern Neck Telephone Company will build a branch line to Lewisetta on the Potomac River in Northumberland County. The Madison Telephone Company is building a branch line from Madison Court House to Criglersville and one to Wolfstown.

ELKINS, W. VA.—The West Virginia Eastern Telephone Company has completed a line between Elkins and Phillipi. The company is building a substantial system in connection with the Bell system.

MILTON, WIS.—The Milton Telephone Company has been sold by its owners, Richardson & Hadden, to Mrs. Oviatt & Son.

EAU CLAIRE, WIS.—The Wisconsin Telephone Company will erect a telephone building at Grand avenue and Farewell street.

KENOSHA, WIS.—The Bristol Rural Telephone Company has applied to the town of Somers for a franchise to build its line through the town, in order to connect the village with the large system now under control of the company. Many Racine County farmers living near the line are asking that the system be extended to their district.

PLYMOUTH, WIS.—At the late meeting of the Wausaukee Telephone Company the following officers were elected: President, E. F. Fox; vice-president and general manager, A. W. Larson; secretary and treasurer, C. Nutt. The capital stock of the company is $10,000. It will establish an exchange at Wausaukee and build toll lines in Marinette and Oconto Counties.

ELECTRIC LIGHT AND POWER.

REDDING, CALIF.—The large iron ore reduction plant to be built thirty miles northeast of Redding, on the Pitt River, will use electric power furnished by the McCloud River Electrical Power Co., which is now building a plant on the McCloud River.

SAN FRANCISCO, CALIF.—The Tuolumne County Electric Company was recently forced to shut down its electric power plant, which supplies power for the mines on the mother lode in Tuolumne County. A heavy storm caused a washout, which carried away sixteen sections of the flume and damaged the ditch.

LOS ANGELES, CALIF.—Orders have been placed for the Pacific Light & Power Company's plant. The boiler order to the Stirling Company called for 1000-hp. McIntosh & Seymour obtained the engine contract. The Westinghouse Electric & Manufacturing Company received a contract for a 750-kw. generator.

SAN FRANCISCO, CALIF.—The Riverside Power Company, of Riverside, Calif., which was recently formed to supply electric light and power in Riverside and Covina, will build a canal costing $85,000. The entire electric power plant, with a capacity of 700 hp, will cost about $200,000. The company will use the water of the Santa Ana River.

SAN FRANCISCO, CALIF.—The Northern Counties Power Company, of California, has been incorporated by I. J. Truman, Joseph Martin, of San Francisco; William Ellery, John R. Phelps, L. B. Edwards, Curtis Hillyer and William F. Buttle. The capital stock is $250,000. An electric plant will be installed in the northern part of the State.

SAN FRANCISCO, CALIF.—The report that the water rights acquired by the Copper Belt Railway and Power Company had lapsed and had been re-located by Thos. Hill, of Redding, Calif., has been denied by the Copper Belt promoters. An electric power plant will be installed on the McCloud River. An electric railway from Bully Hill to Kennett, Shasta County, is also projected.

SAN FRANCISCO, CALIF.—The Mariposa Commercial and Mining Company's California electric power plant is now in successful operation. Current is transmitted at 15,000 volts and is stepped down to 440 volts. The machinery at the mill is operated from one motor, and an additional air compressor at the mine is operated by another. The mine hoist will be driven by compressed air.

CANYON CITY, COLO.—The Colorado Electric Power Company, of Canyon City, has been granted a franchise to light the town of Cripple Creek.

DENVER, COLO.—The Otero County Interurban Light and Power Company, of Denver, has been incorporated. Capital, $1,000,000. The promoters are: Senator Swink, W. B. Cobin, H. P. Dye, J. W. Beaty, F. M. Wieland and C. F. Lacombe. The purpose of the company is to build an electric railway and to furnish power to a number of towns along the route.

DALTON, GA.—Electric light bonds to the amount of $10,000 have been sold and bids will be advertised for at once for the erection of a plant.

CADWELL, IDAHO, has a new electric light plant. A Warren 3,200-volt alternator is in service. Water power will be substituted later on.

POCATELLO, IDAHO.—The Idaho Canal and Improvement Water Power Company, Limited, has been incorporated at Pocatello, with a capital of $500,000, by J. H. Brady, A. B. Melville, W. S. Chaney, A. T. Marshal and F. S. Stobbs. The company will purchase water rights and build a large power plant.

FORT WAYNE, IND.—The Jenney Electric Light & Power Company of this city has been sold to the Fort Wayne Electric Works.

LOUISVILLE, KY.—The Citizens' Lighting Company has received a permit to erect a three-story brick building, practically doubling the capacity of the present plant. A 1,600-kw lighting generator and a power generator of 1,200 hp will be placed in the new addition.

CROWLEY, LA.—The city of Crowley proposes putting in an electric light plant. Information will be given by Mr. Armas Durio.

SPRINGFIELD, MASS.—The municipal electric light plant will receive extensive improvements, at an expense of $10,000. A new engine and dynamo will form part of the new equipment.

WILLIAMSBURG, MASS.—Considerable new equipment will be installed by the recently organized Mill River Electric Light Company of Williamsburg, Mass., which will put in a power plant, using sawdust, shavings and slabs as fuel. Henry W. Hill is treasurer.

NORTH WILBRAHAM, MASS.—The plant of the Whiting Paper Company at this place will be enlarged to double its present size and will be operated by electric power. The new plant will be so designed that source of the power may be steam or water or a combination of both.

MINNEAPOLIS, MINN.—The Cottagewood Water & Light Company, of Minneapolis, has been incorporated with a capital stock of $2,000. Among the incorporators are Fred. Tayran and F. J. Hopkins of Minneapolis.

ST. LOUIS, MO.—The Union Electric Light, Heat and Power Company of St. Louis has been chartered, with a capital stock of $10,000,000. It is the consolidation of the Imperial Electric Light, Heat and Power Company and Citizens' Electric Lighting and Power Company. The directors are E. C. Bruckman, H. P. C. Coats, S. B. Way, J. H. Drabelle, George Milbark, Adolphus Busch, Sam M. Kennard, William J. Lemp, Julius S. Walsh and William L. Nalker.

NASHUA, N. H.—The city's new contract with the Nashua Light, Heat & Power Company makes the price for arc lights $100 per year, and for incandescents $30 each.

OSWEGO, N. Y.—The Oswego Electric Light Company has been organized with a capital of $50,000. The directors are James G. Holleran, John D. McRae and John P. Miller, of Oswego.

LITTLE FALLS, N. Y.—The Consumers' Electric Light Company of this place has been incorporated with a capital of $20,000. The directors are I. N. Lovenheim, P. W. Castler and George D. Ferguson.

NEW YORK, N. Y.—Commissioner Dougherty, of the Department of Water Supply, Gas and Electricity has notified all corporations and companies having overhead electric wires in Brooklyn within two miles of the Bridge that they must prepare immediately to put the wires under the ground.

DURHAM, N. C.—It is reported that J. B. Duke, president of the American Tobacco Company, has placed orders for machinery for a million-dollar cotton mill, to be built at Great Falls, on Catawba River, in Chester county, S. C. The Dukes own enough water power in the South to run a million spindles.

KENTON, OHIO.—The Kenton Cracker Company, Kenton, Ohio, will build a power house and its machinery will be operated by electricity.

SANDUSKY, OHIO.—The American Crayon Company is putting in a new power house with boilers of 475 hp, and a 400-hp engine and a 500-hp generator, accompanied by a Buffalo Forge fan and heater system.

BAKER CITY, ORE.—The City Council has granted a franchise to A. Prescott, J. A. Veness and L. T. Turber for electric light and power privileges.

YORK, PA.—The York Haven Electric Transmission Company has been incorporated with a capital of $30,000. The directors are W. F. B. Stewart, H. L. Carter and James H. Norris.

M'KEESPORT, PA.—The common council has passed the ordinance appropriating $60,000 for the erection of a municipal electric light plant. The measure has yet to pass through the Select Branch, where it will probably meet with some opposition.

TURNER, WASH.—The new malt plant to be erected here will use electric power. The new company will spend about $300,000 in the erection of the plant.

MT. VERNON, WASH.—The Mt. Vernon Water, Electric and Power Company has been incorporated, with a capital of $50,000. W. R. Morgan, R. F. Guerin and H. R. Lamb are interested.

AMERY, WIS.—The Amery Electric Company has been incorporated, with $7,500 capital, by G. G. Griffin, L. Q. Olcott and G. Heald.

THE ELECTRIC RAILWAY.

LOS ANGELES, CALIF.—A positive denial of the report that he had purchased the Los Angeles Traction Company is made by H. E. Huntington, president of the Pacific Electric Railway Company and the Los Angeles Railway Company. The option which Senator W. A. Clark, of Montana, holds on the Los Angeles Traction Company will not expire until July.

RICHMOND, IND.—The Richmond & Northwestern Traction Company, capital stock $50,000, has been organized by G. M. Hodges of Dayton.

PORTLAND, IND.—The Eastern Indiana Traction Company has amended its charter to permit it to build a line from here to Richmond and from Ridgeville to Gas City.

KANSAS CITY, KAN.—The Kansas City Outer Belt & Electric Railway Company has been incorporated with a capital of $1,500,000.

BOSTON, MASS.—The Boston Elevated people state they have agreed to accept a lease of a two-track subway for 25 years at 4½ per cent. at the urgent request of Governor Crane.

UNION CITY, MICH.—The Southern Michigan Traction Company has revived the project for an electric railway from Coldwater to Battle Creek and is securing private right of way.

ALBANY, N. Y.—The Salamanca & Little Valley Railroad Company has been incorporated; capital, $400,000. Directors: J. S. Rockwell and C. W. Hammond of Buffalo; E. B. Vreeland, Hudson Ausley, J. J. Spencer of Salamanca; A. E. Danlow and E. E. Kelly of Little Valley, and D. J. Bissell of Leroy.

NEW YORK CITY.—Work will begin at once on the Eighth street crosstown line, which is to be converted for operation by the electric conduit. This is one of the most important of the crosstown lines, as it taps the heavy passenger business of the Christopher Street Ferry. Later a change will be made on other crosstown lines belonging to the company.

GREENSBORO, N. C.—A deal has been consummated involving the consolidation of all electric light and street railway, gas and power interests of the town. The Greensboro Electric Company is the promoter. Dr. F. A. C. Perrine was elected president at the reorganization meeting.

YOUNGSTOWN, OHIO.—A. W. Jones, John H. Ruhlman and W. S. Anderson, of Youngstown, are promoting an electric railway, to extend from Youngstown to Columbiana.

NEW PHILADELPHIA, OHIO.—The Council has granted a franchise to representatives of Tucker, Anthony & Company for the proposed extension from Massillon to New Philadelphia.

DELPHOS, OHIO.—The promoters of the Lima, Delphos, Van Wert & Ft. Wayne Traction Company announce that construction work will start at once. The power house will be located at Delphos.

BUCYRUS, OHIO.—J. H. Merrill, of Cleveland, has been appointed general manager of the Ohio Central Traction Company and the Mansfield, Crestline & Galion Railway, succeeding W. E. Haycox.

AKRON, OHIO.—The Northern Traction Company has increased the wages of its first year men from 17 cents to 18 cents an hour. Wages of the older men were recently increased from 19 cents to 20 cents an hour.

DAYTON, OHIO.—It is reported that the Dayton, Springfield & Urbana Railway will build its main car shops and repair shops at Dayton instead of at Springfield. The contemplated improvements will cost about $150,000.

TOLEDO, OHIO.—The Toledo & Indiana Railway Company has obtained additional financial backing and is placing contracts for material to build the road. President C. P. Griffin has established offices at 826 Spitzer Building, Toledo.

BRYAN, OHIO.—George Yesbera and J. W. Williams, of this place, are interested in the organizing of the Southern Michigan Electric Railway, which proposes to build from Hillsdale, Mich., to Bryan. A number of franchises have been secured.

FOSTORIA, OHIO.—The Toledo, Fostoria & Findlay Electric Railway Company has decided to commence work within 30 days on the extension of the road from Fostoria to Toledo. All right of way has been secured, and contract has been placed with the Dover Construction Company.

YOUNGSTOWN, OHIO.—The directors of the Mahoning Valley Electric Railway Company have elected the following officers: Murray Verner, Pittsburg, president; C. F. Clapp, Warren, first vice-president; B. F. Miles, Cleveland, second vice-president; John E. McVey, Youngstown, secretary; A. A. Anderson, Youngstown, treasurer and general manager.

OTTAWA, ONT.—A deal has been ratified by which the Electric Tram Company, of Halifax, Nova Scotia, has purchased the property and franchise of the People's Heat & Light Company, thus centralizing in one corporation the electric light and gas interests of that city.

JACKSON, TENN.—The Thompson syndicate of Pennsylvania capitalists has taken charge of the Jackson Street and Suburban Electric Railway. It is understood that the line will be extended.

SALT LAKE CITY, UTAH—De Soto has secured a blanket franchise to construct and operate an electric railway throughout Snowhomish County, Wash.

NEWPORT NEWS, VA.—W. B. Livezey has applied for a franchise for the Newport News and Elizabeth City Railway and Electric Company.

RICHMOND, VA.—The Passenger and Power Company has been awarded a five-year contract for furnishing 600 arc lights of 1,200-candle power at 15 cents per light per night, one cent below the price named in the present contract.

KENOSHA, WIS.—A franchise has been granted the Kenosha Electric Railway Company to lay its tracks through the city, thus completing the connection between Chicago and Milwaukee.

OBITUARY.

MR. A. B. STROWGER, patentee of the Strowger automatic telephone, died in St. Petersburg, Fla., a few days ago.

MR. C. F. WOOD.—A telegram from Boston of June 14 states that Mr. C. F. Wood, ex-superintendent of the Western Union Telegraph Company, died at Newton late that afternoon. Mr. Wood had been connected with the company for forty years, beginning his active superintendency in 1862, and continuing in that office until 1883, when the American Union Telegraph Company came into full control of the Western Union. The fifteen years following Mr. Wood was connected with a commercial house, four years ago returning to the Western Union Company, where he occupied a clerical position until his death. He was eighty-five years of age.

PERSONAL.

MR. E. T. SCHOONMAKER, of Fordham, N. Y., has been awarded a silver medal at the Charleston Exposition for his beautiful magnetic spectra.

MR. E. C. HEADDICK, of the French Westinghouse Electric Company, has been recently on a visit home to Pittsburg from the Havre factory, which has so much business it is likely to be doubled.

MR. H. S. PATTEN, formerly with the New York Heat, Light and Power Company, and more recently with the American Electrical and Maintenance Company, is now associated with Graham Bros. Co., New York City.

MR. C. O. BAKER, JR., the well-known platinum merchant, has just returned from a trip to Europe of some weeks' duration and in good health after the change, his only regret for absence having been to miss the recent electric light convention.

MR. T. W. GOODRIDGE has recently resigned from the secretaryship of the Electric Vehicle Company, with which and its predecessors he had been connected for six years. He has now been appointed maanger of the new automobile department of the Studebaker Bros. Manufacturing Company, of South Bend, Ind., who bid fair to become prominent in the new branch, as they are already in the older lines of carriage building.

MR. DOW S. SMITH, superintendent of the St. Paul system of the Twin City Rapid Transit Company, has been offered and has accepted the position of general manager of the Brooklyn Rapid Transit Company. Mr. Smith is to take the place of J. C. Brackenridge, who has been appointed Engineer of Construction. Mr. Brackenridge has been acting as general manager for the company ever since the Brooklyn Heights, the Nassau and the other systems which now compose the Brooklyn Rapid Transit Company were combined.

MR. J. C. STEWART, the American contractor, whose record bricklaying performance in connection with the erection of the British Westinghouse Electric & Manufacturing Company's works at Manchester, England, recently caused so much discussion, has been engaged by the Midland Railway Company to supervise and expedite the work at the mammoth Midland Railway Hotel at Manchester. The contract is in the hands of Messrs. William Brown & Son, of Salford, England, and it is said that they are to receive $100,000 in bonuses if the work is finished within a year, and $10,000 a month for each month shorter than that time. The total price is $5,000,000.

COL. ALLAN C. BAKEWELL, second vice-president and general manager of the Sprague Electric Company, has been nominated for the office of Department Commander of the New York G. A. R. Col. Bakewell will not make a personal canvass, but his comrades of the Lafayette Post, of which he is past commander, assume all responsibility and feel assured of his election at the encampment at Saratoga Springs this month, because of his unselfish and untiring devotion to the high principles of the order. Col. Bakewell has been largely instrumental in perpetuating respect for our country's flag by virtue of the work he has accomplished as chief aid on the staff of the Commander-in-Chief in charge of the military instruction and patriotic education in the public schools. His election to the office of Department Commander would reflect great credit upon the wisdom of the G. A. R.

Trade Notes.

FEE & STEWART CO., Melbourne, Fla., wish to receive electrical supply catalogues.

CHANGE OF NAME.—The Abbott Electric and Manufacturing Company of Warren, Ohio, has changed its name to United States Brass and Manufacturing Company.

MESSRS. WILLIAM H. WESTON & CO., Philadelphia, have just completed and installed in the Masonic Temple of that city an eight-panel blue Vermont marble switchboard.

EMERSON FANS.—The Emerson Electric Manufacturing Company is sending out a mailing card of unique design, relating to an entirely new type of ceiling fan for low-frequency current.

SMITH & HEMENWAY CO., of No. 296 Broadway, New York, has bought out the entire business of the Yankee Company, including all contracts, patents, machinery, etc., relative to the Yankee nail-puller.

ELECTRIC CUTTERS.—The Nopper Electrical Cutting Machine Company, Baltimore, to manufacture and deal in electrical cutting machines, capital, $150,000, has been incorporated under the laws of Delaware.

McCULLAGH & CO.—The partnership between A. McCullagh, Jr., L. A. Clark and Prof. E. J. Houston, under the firm name of McCullagh & Co., with offices at New York and Philadelphia, has been dissolved by mutual consent.

PANEL BOARD CABINETS.—A description of cabinets for use with Zimdars & Hunt's standard panel boards is given in Bulletin 35 recently issued by that firm. A price-list of boxes, trims, doors, etc., is also given, together with code words.

CENTRAL MANUFACTURING CO., of Chattanooga, Tenn., in spite of its recent fire, is filling orders for pole line material more promptly than ever. The fire simply gave it a chance to show what it could do in the way of "humping itself" to meet demands for its specialties.

THE WOTTON ELECTRIC & MFG. CO., Atlanta Ga., has not only been doing a large business from its home office, but the Thomas G. Grier Co., 128 West Jackson Boulevard, Chicago, managers of the Western sales department, have also found business very good in their territory.

THE CAPITAL ELECTRIC COMPANY, of Denver, Colo., has purchased two lots on California Street in that city on which it will build a factory for the manufacture of incandescent lamps. The company was organized four years ago and has twice before been compelled to double its capacity.

SECOND-HAND ELECTRICAL APPARATUS.—The Chas. E. Dustin Company, No. 11 Broadway, New York, has just issued a list of second-hand electrical apparatus, boilers and engines, which it has on hand for immediate delivery. The company states that its apparatus is in first-class condition and guaranteed.

OIL FILTERS.—A few weeks ago The Burt Mfg. Co., of Akron, Ohio, received an order for a large Cross oil filter from the Anheuser-Busch Brewing Association of St. Louis, which was shipped and gave such excellent satisfaction that the Burt Company has just received a duplicate order from it.

"WOOD" ALTERNATING ARC LIGHTING.—The "Wood" multiple system of alternating current enclosed arc lighting for street service is the subject of Bulletin No. 1,023 of the Fort Wayne Electric Works, Fort Wayne, Ind. The system is very completely described and illustrated. Some interesting candlepower curves are also shown.

MR. GEORGE PAROSCHOL, of Athens, Greece, who was graduated in June from the Massachusetts Institute of Technology, has enrolled in the American School of Correspondence of Boston. Mr. Paroschol expects to complete the school's course in the fall, when he will return to Greece to accept an engineering position under the government.

ELECTRIC AUTOMOBILES.—The Electric Storage Battery Company has reprinted as one of its standard bulletins, the article of Mr. W. H. Palmer, Jr., printed in the ELECTRICAL WORLD AND ENGINEER of April 12, 1902. This article, which is illustrated, constitutes a valuable addition to the available literature on this important subject.

COAL HANDLING.—The C. W. Hunt Company, in Circular No. 028, illustrates and describes a number of examples of economic coal handling, in which Hunt machinery is used. A large coal handling plant recently installed for the Baltimore City Consolidated Railway Company is illustrated and described in detail in the opening pages.

FERRANTI METERS.—Ferranti, Limited, Hollinwood, Lancastershire, England, has issued a catalogue devoted to the Ferranti type of direct-current meters. The Ferranti meters are of the interesting mercury motor type. That is to say, the current to be measured sets in motion a mass of mercury, which drags with it a vane, the steam of which actuates the recording mechanism.

"PROFITABLE ADVERTISING," a bright and up-to-date monthly periodical issued in Boston, has devoted its June issue very largely to a general treatment of the subject of advertising with the use and aid of electric lighting. The electrical features of the number are given generous space, and as the articles are illustrated they are unusually attractive to the miscellaneous reader in other lines of trade.

"KILFYRE" MEDAL AWARD.—In noting in our last issue the award of a medal to the Monarch Fire Appliance Company, the source of the medal was not given, which was the Charleston Exposition. The Monarch Fire Appliance Company informs us that the gold medal received was the only medal awarded at Charleston to any fire extinguisher, whether dry, chemical or liquid.

KEYSTONE INCANDESCENT LAMPS.—The Pittsburg Incandescent Lamp Company, Pittsburg, Pa., in a handsome 16-page pamphlet describes and illustrates the various types of incandescent lamps of its manufacture. The final pages gives some instructive information on ordering lamps, with respect to voltage and efficiencies, which should prove useful to all users of incandescent lamps.

TELEPHONE APPARATUS.—The full line of telephone apparatus manufactured by the Sumter Telephone Manufacturing So., Sumter, S. C., is described in a series of bulletins issued by that company. The list includes long-distance telephones, "Bull's-Eye" express switchboards, lighting arresters, distributing frames, etc. These different instruments are illustrated and briefly described.

MARINE APPARATUS.—The Holtzer-Cabot Electric Company, Boston, Mass., makes a compact and efficient thirty-light marine generating set, which appeals to yachtsmen and other boat owners. Its total weight is only 300 pounds. This apparatus is described and illustrated in Bulletin No. 133 issued by the company. The same bulletin contains descriptions and illustrations of launch motors and other apparatus made by this company.

REYNOLDS-CORLISS ENGINES.—The Allis-Chalmers Company, Milwaukee, Wis., has issued a 184-page catalogue devoted to Reynolds-Corliss and other engines manufactured by the company. The catalogue is well printed on coated paper, and illustrates not far from 100 different forms of engines. The opening pages contain views of the great works of the company, which rank with the largest engineering works in the world.

BUFFALO DISK WHEELS.—The Buffalo Forge Company, Buffalo, N. Y., is sending out a mailing card containing illustrations of three types of Buffalo disk wheels. These wheels are designed for ventilation, cooling and drying, and are adapted to many other requirements and situations. On the front of the card is a yachting scene, with the suggestion that the home or office can be made just as cool by using Buffalo disk wheels.

REMOVAL NOTICE.—The Monarch Fire Appliance Company, New York, has removed its general offices from No. 27 William street to No. 247 Pearl street, where its business, manufacturing and shipping departments will all be under one roof. This change was rendered necessary in order to properly handle the company's rapidly increasing business. The demand for "Kilfyre" is a healthy and steadily increasing one; it is an effective protective appliance and is death to a fire.

THE CONSUMERS' INCANDESCENT LAMP COMPANY, Owensboro, Ky., has been running for three months in the manufacture of the "Premier" incandescent lamp. It has a modern plant, with a daily capacity of 2,500 to 3,000 lamps, and a highly satisfactory outlook. The company reports that its lamps are giving excellent satisfaction, one concern alone having given twenty-four orders in two months. Mr. A. H. Kreitler is secretary and general manager of the company.

FAN MOTORS.—A highly artistic catalogue has been issued by the Emerson Electric Manufacturing Company, St. Louis, with the title, "Fan Motors and Ceiling Fans for Alternating Current—Season 1902." All of the numerous types of Emerson fan motors and fans are illustrated by excellent half-tones. Accompanying each type of fan is a detailed description, and the final pages of the book give directions for putting up and connecting fan motors, and instructions how to order parts and repairs.

KELLOGG TELEPHONE APPARATUS.—The Kellogg Switchboard and Supply Company, Chicago, has issued a catalogue illustrating some of the exchanges which it has installed. Advantage has been taken of the new process of half-tone printing on a roughened surface, and with most excellent results. Among the illustrations are views in Kellogg exchanges at Johnstown, Pa., Wilkesbarre, Pa., Indianapolis, Ind., Columbus, Ohio, Scranton, Pa., St. Louis, Mo., Cleveland, Ohio, and Philadelphia, Pa.

RAW-HIDE GEARS AND PINIONS.—The New Process Raw-Hide Company, Syracuse, N. Y., has issued a neat booklet on its noiseless raw-hide gears and pinions for electric motors and high-speed machinery. The process of preparing the hides and the making of pinions by this new process are briefly described, and the advantages of their use pointed out. The company makes raw-hide washers, bushings, etc., besides pinions. The booklet comes in a substantial wallet to carry in the pocket.

CEDAR TIES.—The Maltby Lumber Company, of Bay City, Mich., recently sent out a special train load of cedar ties to the street railway of Des Moines, Ia. The arrangement with the railroad company was that the train should be run as a special during daylight hours and lay over at nights. This is only part of an order for the same company; previous deliveries have been made, and a second similar shipment will be sent in the course of a week or so. The same company will soon send a train load of cedar poles to Arkansas.

THE FALCON ELECTRIC MANUFACTURING COMPANY, of No. 432 East Seventy-first street, New York City, announces that, owing to the large demand for its switches, panel boards, flush receptacles, etc., it has opened an office for the convenience of contractors and the electrical trade at No. 15 Cortlandt street (telephone No. 3901 Cortlandt), where it will carry a complete line of its standard products. In the future all communications with the Falcon company should be addressed to the offices of the company, No. 15 Cortlandt street. Mr. H. O. Swobodo is secretary.

ROLLER BEARINGS.—The question of reduction of friction in bearings is an important one and is of growing interest with the trade in general. Some valuable information on the subject is given in two bulletins (Nos. 23 and 24) recently issued by the Hyatt Roller Bearing Company, Harrison, N. J. Bulletin No. 23 gives the results of comparative tests of the Hyatt flexible roller and solid steel rollers made by the Franklin Institute of Philadelphia, and No. 24 is on the subject of Hyatt flexible roller bushings as applied to loose pulleys. The Hyatt roller bearing is applicable not only to shafting in the mechanical transmission of power, but to all kinds of special machinery, no matter what the conditions of speed and load.

ADJUSTABLE FIXTURES—The O. C. White Company, Worcester, Mass., manufacturers of adjustable incandescent lamp fixtures, has just issued a very complete catalogue of its products. It would be hard to find a requirement as to the disposition of light that this company has not provided for in its devices. Numerous manufacturing plants are equipped with these fixtures, and many offices, draughting rooms, libraries and banks are using them with advantage. By their use the light can be thrown directly upon the work. The company has lately brought out some new styles of fixtures. These, with all of the earlier styles, are illustrated and described in the new pamphlet. Those who are not familiar with these fixtures would do well to investigate their merits.

NEW YORK EDISON BULLETIN.—The June bulletin of the New York Edison Company is a particularly attractive and interesting number. In addition to much readable matter concerning some of the novelties of that enterprising company, there is a supplement consisting of a handsome reproduction of one of the photographs of Lord Kelvin, taken while that distinguished gentleman was in this country, last April and May. It represents him reading, the posture being easy and natural. It is a beautiful piece of work, artistically and mechanically considered, and is entirely suitable for framing. A neat little reference is made in the bulletin to the farewell dinner given to Lord and Lady Kelvin by Mr. Anthony N. Brady, president of the New York Edison Company, on May 8. The bulletin itself is an artistic production and is very attractively illustrated.

CHARLES H. BESLY & CO., No. 10 North Canal street, Chicago, Ill., report their business very good. They are receiving orders for Gardner grinders from all parts of the country. Within the past month shipments have been made to California, New York, Rhode Island, Connecticut and New Jersey. The spiral circles in their various forms used in connection with the spiral grooved steel disc, which is the distinctive feature of the Gardner grinder, enables users of the Gardner grinder to do from 50 per cent. to 200 per cent. more work than either solid or coated wheel will do. Many shipments of Helmet oil, Badger and Bonanza grease cups are being made to all parts of the country. Numerous inquiries for catalogues and circular matter relating to their own specialties, as well as requests for general catalogues, estimates and prices on shop equipments indicate a healthy condition of trade throughout the country. Their new 300-page illustrated catalogue will be sent free to any address upon application.

MONARCH ENGINE STOP.—The Consolidated Engine Stop Company, No. 100 Broadway, New York, has just issued a very handsome and artistic pamphlet describing and illustrating the Monarch system of automatic safety devices for use on steam and electric motors. By the use of the engine stop the engine is stopped automatically in those emergencies where the loss of property and life may depend upon the promptness with which this is accomplished. The engine may be closed down from any part of the building by pressing a button. The speed limit is a device for automatically preventing an excessive speed of the engine. It is directly connected to the main fly-wheel shaft and can be set to act at any number of revolutions. Another "Monarch" device is a vacuum valve, which breaks the vacuum in the condenser automatically, and prevents the cylinder from taking water when the throttle is closed and the pressure shut off. The circuit-breaker trip for electric light and power plants automatically trips the circuit-breaker in the generator circuit at the same time the engine throttle valve is closed by the stop. The pamphlet is very clearly illustrated, with perspective and sectional views of the various devices, and at the back a list is given of many prominent users of the devices. General managers, superintendents and engineers of power plants and all steam plants will find much of interest to them in this pamphlet, a copy of which may be had on application to the company's headquarters at the address above given.

Record of Electrical Patents

UNITED STATES PATENTS ISSUED JUNE 10, 1902.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., New York.]

701,453. CARBON SORTING MACHINE; M. M. Zellers, Cleveland, Ohio. App. filed Feb. 15, 1902. The invention includes an open electric circuit in which the carbons may be connected to be tested, a guide-plate by which the carbons when withdrawn from said circuit are guided in one direction or another, and mechanism for controlling the movement of said guide-plate, which mechanism is caused to operate according as the resistance of the carbon being tested is less or greater than the theoretically correct resistance. (Issued June 3.)

701,832. GAME OR PUZZLE; J. H. Bennett and M. L. Zimmerman, Philadelphia, Pa. App. filed Sept. 10, 1901. The game is made to represent a spider web in which there is a movable spider and fly. To the former is attached a small magnet, and to the latter an armature. The object is to manipulate the puzzle so that the spider will catch the fly and drag it through the several passages to the center.

701,943. AUTOMATIC CONTROLLER FOR ELECTRIC MOTORS; N. A. Christensen, Milwaukee, Wis. App. filed Oct. 21, 1901. The common core of two solenoidal magnets carries a contact piece which makes and breaks the circuit of a motor adapted to drive an air-compressor.

701,947. INSULATOR; V. G. Converse, Pittsburg, Pa. App. filed Aug. 2, 1901. A knob insulator built up of a number of sections, one set within the other and all strung upon a pin.

701,848. INSULATOR; V. G. Converse, Pittsburg, Pa. App. filed March 17, 1902. A modification of the preceding.

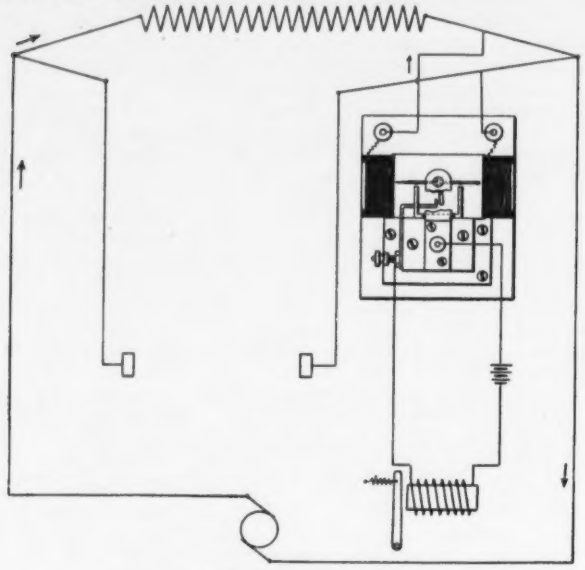
701,875. CABLE TERMINAL; E. Gonzenbach, Wheaton, Ill. App. filed April 11, 1902. A casting adapted to fit over the end of the conductor, combined with an insulating bushing and having a binding post for connections.

701,886. SYNCHRONIZING ALTERNATORS; R. E. Huthsteiner, Schenectady, N. Y. App. filed Sept. 14, 1899. (See Current News and Notes.)

701,914. FAN MOTOR ATTACHMENT; W. S. Moody, Schenectady, N. Y. App. filed Oct. 26, 1900. A suspended fan motor is provided with an arm extending from the casing to a point beyond the tips of the fan blades, where it carries a circuit closer, the arm being flexible, so that it may be adjusted to various positions.

701,915. PROCESS OR FORMING SECONDARY BATTERY ELECTRODES; W. Morrison, Chicago, Ill. App. filed June 18, 1900. While the plates are undergoing the forming process, they are protected by a covering of porous material, which prevents the separation of the lead from the plate during the process, while permitting of the escape of the gases. After forming the cover is removed.

701,917. SECONDARY BATTERY; W. Morrison, Chicago, Ill. App. filed June 18, 1900. The element is made up of sheets of lead leaf, perforated and rolled together.



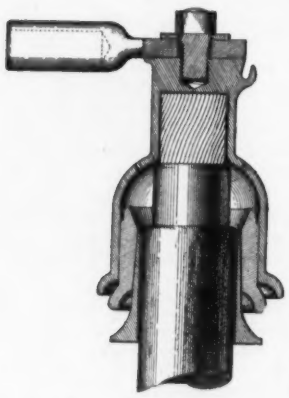
701,453.—Carbon Sorting Machine.

701,918. MEANS FOR PREVENTING THE DISTORTION OF SECONDARY BATTERY PLATES DURING FORMING; W. Morrison, Chicago, Ill. App. filed June 18, 1900. A bifurcated wooden plate straddles the electrode and holds it centered between the walls of the cell.

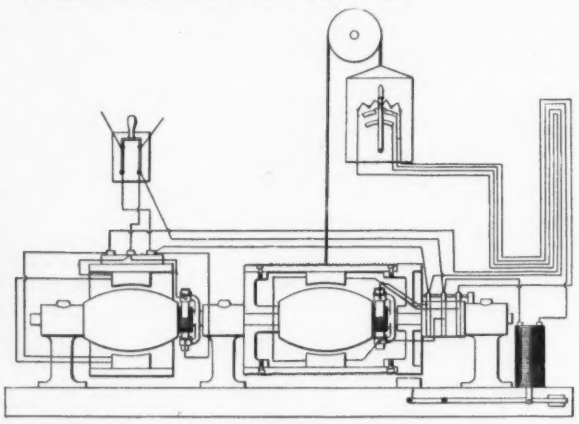
701,925. TROLLEY CROSSOVER; T. North, Aurora, Ill. App. filed Sept. 4, 1901. A device to prevent the trolley wheel from coming in contact with the track on which the car-barn door rides.

701,937. INDICATING INSTRUMENT; L. T. Robinson, Schenectady, N. Y. App. filed Nov. 20, 1899. (See Current News and Notes.)

701,947. MEANS FOR TRANSMITTING SYNCHRONOUS MOTION TO DISTANT POINTS; L. Saxon, New York, N. Y. App. filed Oct. 18, 1901. An actuating device for the main controller comprising a multipolar direct-current motor having a permanently polarized armature and a field magnet containing twice as many poles as the armature and a master controller for alternately energizing alternate poles in order to produce a step by step movement of the armature, in synchronism with the motion of the motor controller.



701,875.—Cable Terminal.



702,155.—Electric Motor.

701,949. ELECTRIC INCANDESCENT LAMP HOLDER; E. G. Sheppard, London, Eng. App. filed Dec. 11, 1900. In lamps requiring three points of contact in the holder, the contacts are arranged so that it is only possible for them to engage to close the circuit when adjusted in one position, where they also become locked.

701,958. AUTOMATIC CUTOUT; C. P. Steinmetz, Schenectady, N. Y. App. filed March 6, 1899. (See Current News and Notes.)

701,959. GLOWER FOR PYROELECTRIC LAMPS, AND PROCESS OF MAKING SAME; C. P. Steinmetz, Schenectady, N. Y. App. filed Nov. 6, 1901. (See Current News and Notes.)

701,965. ELECTRIC METER; E. Thomson, Swampscott, Mass. App. filed Oct. 23, 1900. (See Current News and Notes.)

701,986. TERMINAL FOR ELECTRIC FURNACES; E. G. Acheson, Buffalo, N. Y. App. filed May 24, 1899. (See page 1097.)

702,032. INDUCTION APPARATUS; W. Scheidel, Chicago, Ill. App. filed Jan. 23, 1902. In order to readily assemble the parts, the secondary coil is composed of a series of bobbins supported independently inside the casing, the primary coil being arranged centrally within the secondary coil and supported at its ends independently of the latter.

702,073. SUPPORT AND SWITCH FOR ELECTRIC DENTAL INSTRUMENTS; E. O. Pieper, San Jose, Calif. App. filed Jan. 2, 1902. Details.

702,081. MANUFACTURE OF GLASS BY ELECTRICAL HEATING; A. Voelker, Ehrenfeld, Germany. App. filed Sept. 27, 1900. (See page 1097.)

702,117. ART OF PRODUCING CHEMICALS IN ELECTRIC FURNACES; E. R. Taylor, Penn Yan, N. Y. App. filed Oct. 6, 100. (See page 1097.)

702,142. METHOD OF BLEACHING PAPER PULP, ETC.; F. H. Long, Chicago, Ill. App. filed June 24, 1901. (See page 1097.)

702,028. TELEPHONE SWITCHBOARD; J. M. Overshiner, Elwood, Ind. App. filed Dec. 15, 1900. (See page 1098.)

702,149. SWITCHBOARD FOR ILLUMINATING ELECTRIC LAMP SIGNS; M. Norden, New York, and L. S. Crandall, Brooklyn, N. Y. App. filed March 19, 1902. An arrangement for utilizing the cards of a Jacquard apparatus for displaying different letters and figures successively.

702,152. ELECTRICAL CONTROLLING APPARATUS; R. F. Piatt, Louisville, Ky. App. filed Feb. 25, 1902. Automatic apparatus for controlling the motor of a compressor by means of the pressure and the current delivered to the motor.

702,155. ELECTRIC MOTOR; H. Rowntree, Chicago, Ill. App. filed Nov. 23, 1899. The hoisting drum of an elevator is connected to one of the parts of a motor in which both the field and armature rotate and means are provided for driving one of the parts and for maintaining the rotation of both parts at different speed ratio.

702,184. MAGNETIC ORE SEPARATOR; J. W. Carter, Franklin, N. J. App. filed Nov. 29, 1901. Details relating to the arrangement of the magnets with reference to the chute.

702,192. GAS LIGHTING OR EXTINGUISHING DEVICE; V. Forti, Paris, France. App. filed Oct. 24, 1900. Details.

702,213. ELECTRICITY METER; E. G. Holm, Berlin, Germany. App. filed Dec. 21, 1901. (See Current News and Notes.)

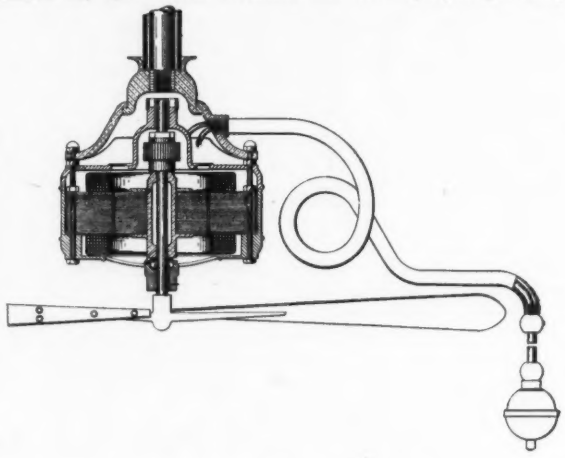
702,247. ADJUSTABLE SWITCH OR OUTLET BOX; J. H. Rusby, Nutley, N. J. App. filed Dec. 23, 1901. Means for adjusting or leveling the box against the wall.

702,263. AUTOMATIC TELEGRAPHIC TRANSMITTER; J. A. Toomey, Goshen, Ind. App. filed Feb. 18, 1902. Openings are cut through a tablet of insulating material to expose a conducting surface, said openings representing Morse characters, which are transmitted by dragging a "toucher" over the characters.

702,272. COMMUTATOR SEGMENT; W. H. Windle, Philadelphia, Pa. App. filed April 21, 1902. A commutator segment having a finger bent upward therefrom at one end and adapted to be connected with the armature coil.

702,314 to 702,321. ELECTRIC TUBE LIGHTING; D. McF. Moore, Newark, N. J. Apps. filed Dec. 18, 1901, and Jan. 2, 1902.

702,339. TELEGRAPHIC APPARATUS; S. G. Brown, Putney, England. App. filed March 29, 1900. This invention has for its object punching apparatus which is adapted to be automatically operated by signaling impulses received at siphon-recorded speed from a cable or line section in such manner as to punch signaling perforations in a tape after reinserting or interpolating the impulses that may have been lost, so as to assure accuracy in the reproduction of the signals.



701,914.—Fan Motor Attachment.

702,361. STORAGE BATTERY; A. D. Edgerton, Philadelphia, Pa. App. filed Nov. 13, 1900. The plates are in the form of lead pans, one above the other, the rims of which are perforated to allow the solution to overflow from one pan into the next below it and thus maintain a uniform specific gravity of the solution throughout a number of cells connected together.

702,362. TEST CUP; W. W. Emmons, Boston, Mass. App. filed Nov. 6, 1901. The cup is inserted in the armor of the cable and contains cable terminals from which tests may be made.

702,364. ELECTRIC SWITCH; J. J. Flint, Denver, Colo. App. filed July 29, 1901. Details.

CONDUITS FOR TELEPHONE WORK.

GENERAL CONTRACT AND SPECIFICATIONS.

GENERAL CONTRACT AND SPECIFICATIONS

FOR

UNDERGROUND CONDUITS.

THIS AGREEMENT made and concluded this..... day of.....in the year Nineteen Hundred and .....by and between the..... COMPANY, a corporation organized and existing under the laws of the State of.....having its principal business office in ....., party of the first part, and .....of the City of.....State of..... party of the second part, WITNESSETH:

SECTION 1.

1 Contract

That the party of the second part has agreed, and by these presents does agree with the party of the first part, for and in consideration of the prices, and agreements hereinafter set forth, well and truly to be paid and performed by the party of the first part, and under the penalty expressed in a bond bearing..... date with these presents and hereunto attached, to perform at his own proper cost, all of the work or portions thereof, and to furnish all labor, materials, machinery, tools and appurtenances herein specified, entirely in accordance with the specifications and plans hereinafter referred to, and subject to the approval of the city authorities of the.....

SECTION 2.

2 Definitions

All words referring to the respective parties shall be taken to be of such number and gender as the character of the parties require.

(a) The word "Company" shall mean the ..... COMPANY, which has entered into this contract as party of the first part.

(b) The word "Contractor" shall mean the party of the second part thereto, who has entered into this contract to perform the work called for by the specifications.

(c) The word "Engineer" or "Superintendent" shall mean the Engineer or Superintendent of the..... COMPANY as the case may be, acting either directly, or through his proper agents.

(d) The word "Conduit" shall mean the aggregation of a number of hollow tubes of duct material arranged to furnish so many longitudinal passage ways in the streets, for the reception of electric cables. A section of conduit shall mean such a portion of conduit as connects any two adjacent manholes, measured between the centers of these manholes.

(e) The word "Duct" shall mean a single continuous longitudinal passage way extending between any two adjacent manholes, or from one manhole to any distributing point.

(f) The phrase "Duct Material" shall mean any suitable material out of which ducts may be built.

(g) The term "Manhole" shall mean an underground vault or chamber so built as to give access to a portion of the conduit, and into which the conduit is built, including an opening from the street surface by which access may be had thereto.

(h) The word "Lateral" shall mean one or more ducts extending from a manhole, or from one or more of the main conduit ducts to some distributing point.

SECTION 3.

NO. 1. GENERAL SPECIFICATIONS.

3 Description and Location

The work consists in furnishing all labor, materials, machinery, tools and appliances that shall be needed to build and complete, including all excavations, refilling and repaving, in accordance with these specifications and plans, the requirements of the Engineer or Superintendent and City authorities, the Underground System, as indicated in the schedules and plans accompanying these specifications, together with such additions or subtractions as may be directed by the Engineer or Superintendent, from time to time during the progress of the work, as hereinafter provided.

NO. 2. SCHEDULE A.

List and location of Conduits.

.....

.....

NO. 3. SCHEDULE B.

List and location of Manholes.

.....

.....

NO. 4. SCHEDULE C.

List and location of Laterals.

.....

.....

SECTION 4.

4 Changes in Location

The Schedules A, B, and C give the location and enumeration of the conduits, manholes and laterals that it is now the intention to build, but it is agreed that from time to time during the prosecution of the work, and before the final completion thereof, any additions, extensions or subtractions shall be constructed by the second party if required by the first party. The terms and conditions of this agreement shall apply to, and cover all such additions and extensions, provided that such work is reasonably similar to that which is now contemplated by said schedules. It is also agreed that the first party may decrease the amount of work in any way it shall deem advisable, without becoming liable to the second party for any compensation or damage from such change, provided the first party shall notify in writing the second party of any and all changes before instructions are given for the commencement of work upon the portions which are changed.

SECTION 5.

5 Delivery of Material Supplied by the Company

(a) The duct material shall be delivered to the Contractor, either in F.O.B. cars or boat in ..... City, or at the store yard of the Company, at ..... and the Contractor must provide sufficient facilities to haul away and to store the duct material as fast as it shall be received. If delivered to the Contractor F.O.B. cars or boat, he shall be responsible for all damage or demurrage charges which may be incurred by failure to remove the material from the cars, freight yards or freight houses within the time usually allowed by the transportation companies for this purpose.

(Cancel paragraph (a) if duct material is supplied by Contractor.)

(b) The iron work for the manholes shall be delivered to the Contractor either at the foundries making the same or at the store yard of the Company or F.O.B. cars or boat in the City of ..... The Contractor must provide sufficient facilities to remove, haul and store this material as fast as it may be delivered.

(Cancel paragraph (b) if iron work is supplied by Contractor.)

(c) Upon the delivery of any material to the Contractor, he shall give a written receipt to the Engineer or Superintendent for the same, and after the delivery the Contractor shall be responsible for the safety and care of all such material, shall do all the handling and storing at his own expense, and shall replace at his own expense any and all material which may be lost or injured. On the completion of the work herein called for, the Contractor shall deliver at ...s own expense to the store yard of the Company any and all surplus material of this kind. If the Company shall fail to deliver to the Contractor from time to time any of the material herein specified to be furnished by the Company, the Contractor shall not allege any such failure as any ground for damages. But for each and every day that the Contractor is delayed by the failure of the Company to deliver said material, he shall be allowed one extra day's time over and above that hereinafter stipulated for the entire completion of the work called for.

SECTION 6.

6 Power of Engineer or Superintendent

All work under this contract shall be done to the satisfaction of the Engineer, or Superintendent, who shall, in all cases, determine the amount, quality, acceptability and fitness of the several kinds of work and materials which are to be paid for hereunder, and who shall also decide all questions which may arise as to the fulfillment of any or all of the several clauses of this contract and specifications. The decision of the Engineer or Superintendent shall be final, and binding on the Contractor, and in case any question shall arise, such decision shall be a condition precedent to the right of the Contractor to receive any money hereunder.

SECTION 7.

NO. 1. PLANS AND INSTRUCTIONS.

7 Work to Be Done in Accordance With Plans, Specifications and Instructions

Attached to this contract are plans showing the general location of the Underground System herein called for, so far as this location can be pre-determined, but during the progress of the work the Engineer or Superintendent will give to the Contractor such specific instructions and plans as will fix the exact location upon each street of the conduits, manholes and laterals, both line and grade, and the work shall be done in accordance with the plans and specifications annexed and in accordance with such additional plans and directions as may be given. For each section of conduit, for each manhole and for each lateral the Engineer or Superintendent shall give to the Contractor a detailed plan and working instructions. Such plans or instructions shall show the location of the center line of the excavation with reference to the center of the street, the width and the depth of the trench for the conduit, the laterals and the manholes, and shall specify any points intermediate between manholes, at which there may be any change in width or grade. These plans and working instructions shall specify the grade of the center of the conduit with reference to a level line. The plans and working instructions shall give the number of ducts in each section, and the arrangement of these ducts, both vertically and horizontally, shall show the kind, location and grade of each manhole.

NO 2. ERRORS IN PLANS OR SPECIFICATIONS.

The plans, sepcifications and instructions are explanatory of each other, and are intended to be sufficiently explicit to cover the proper construction of the work, in so far as it is possible to define work of this character. The Company, however, does not warrant the plans to be absolutely correct, nor that every possible contingency can be covered, but should any discrepancy appear, or any misunderstanding arise as to the import of anything contained either in the plans, specifications or instructions, the Contractor agrees to accept the explanation of the Engineer or Superintendent as final and binding. Any correction of errors or omissions in the plans and specifications may be made by the Engineer or Superintendent when, in his judgment, such correction is necessary for the proper fulfillment of the intention and meaning of the plans and specifications.

SECTION 8.

8 Orders to Contractor

Whenever the Contractor is not present in person upon any part of the work where it may be necessary to give instructions, such instructions as may be given by the Engineer or Superintendent shall be received and obeyed by the Foreman, or other persons in charge of the particular work in reference to which orders are given.

SECTION 9.

9 Access to Work

The Contractor shall at all times afford the Engineer or Superintendent access to any and every part of the work and enable him to examine and inspect all machinery, materials or appliances which are used thereon, and all facilities for ascertaining the skill and compentency of any and all men employed.

SECTION 10.

10 Competent Men, Suitable Tools and Acceptable Materials

The Contractor shall employ only skillful, competent and orderly artisans who are thoroughly familiar with and able to do the several kinds of work to which they are assigned. If the Engineer or Superintendent shall find men who, in his opinion, are unskillful, or who are not thoroughly carrying out the provisions of the specifications or who are disorderly, or who are not suitable, he shall notify the Contractor in writing of his disapproval of such men, and upon receipt of such notice, the Contractor shall discharge from the work any and all such men, and shall not again re-employ them upon this work. The Contractor shall supply all necessary and suitable tools, appliances and machinery for carrying on the work in a proper manner at such a rate as may be requested by the Engineer or Superintendent. If the Contractor shall fail to supply appropriate tools and appliances or a sufficient amount thereof, the Engineer or Superintendent shall notify the Contractor in writing of this failure, and if the Contractor shall continue to fail for five days to supply such a quantity or quality of tools, machinery or appliances as shall, in the judgment of the Engineer or Superintendent, be suitable and adequate for the purpose, or if the Contractor shall fail to constantly keep all tools and machinery in proper and adequate repair, the Company may then consider that the Contractor has failed in the performnce of his part of the contract, and may assume and carry on any, or all such portions, and shall charge against the Contractor any and all expense required to complete the same. The Contractor shall also supply a suitable quantity of acceptable materials, which shall meet in all respects all the provisions of these specifications. In case any material whatsoever shall fail to meet the material specifications, or any of the tests prescribed thereunder, or shall not be in accordance with the samples submitted as provided for in these specifications, or shall not be supplied in sufficient quantity, the Engineer or Superintendent shall notify the Contractor in writing of his failure to supply appropriate materials or sufficient quantity thereof, and on receipt of this notice the Contractor shall immediately replace such rejected materials with such as shall fulfill all of the provisions of the specifications, or shall increase the quantity delivered as may be requested. If, forthwith, after such notice the Contractor fails to supply appropriate and acceptable materials or a sufficient quantity thereof, the Company shall have the right to assume and carry on the work under the clauses for abandonment, as hereinafter specified, and shall charge against the Contractor, any and all expense required to complete the same.

SECTION 11.

11 Replacement of Defective Work

If the Engineer or Superintendent shall discover that any portion of the work is not constructed in accordance with the specifications, plans and directions, or if he shall find that any portion of the work has been constructed with poor materials, or unskilled labor, or is in any way defective, he shall notify the Contractor in writing of such imperfections and the Contractor shall, upon receipt of such notice, remove at once all such defective work and shall replace the same with that which is in accordance with the plans, specifications and instructions, and which shall meet the approval of the Engineer or Superintendent. In case the Contractor shall fail to remove or replace any or all such defective work forthwith, after receipt of notice of rejection, the Company shall have the right to remove such defective work and to correct or replace same with such as is in accordance with the specifications, and shall charge against the Contractor any and all expense of such replacement.

SECTION 12.

12 Legal Authority

The necessary legal authority to occupy and open the streets upon which the underground system is to be placed shall be obtained by the Company, in the form of the customary written permits for such occupation and opening and shall be delivered to the Contractor as his authority for the work. If after the receipt by the Contractor of this permit the same shall be lost or destroyed, the Company shall on written notice from the Contractor take out a new permit and shall charge against the Contractor all the necessary expense of obtaining such duplicate permit.

SECTION 13.

13 Work to Be Done in Accordance with Law and City Regulations

In all operations in any way connected with the work herein specified, the Contractor shall comply with all the laws of the land, and with all the city rules, ordinances and regulations affecting in any way the conduct of those engaged, or the methods of doing the work, or in the use of materials, tools, appliances or machines.

SECTION 14.

14 Responsibility of Contractor

During the progress of the work the Contractor shall take all precautions and shall assume all responsibility of whatsoever nature for the prevention of any and all injuries to any person whatsover, whether employed by the Contractor or not. He shall and does hereby assume all responsibility and liability for any injury or damage of whatsoever nature, to any property or persons, and shall and does hereby assume all liens, suits or claims for damages, either to life, limb, property or persons, arising from any act or omission, or from the amount or character of the work, or the way in which it is done, and shall and hereby agrees to save harmless the Company, its officers and agents from all claims relating to any damage or injury, actual or consequential, present or future.

SECTION 15.

15 Liens Upon the Work

Upon the completion of the work and before the final payments are made to the Contractor, he shall file with the Company suitable evidence that all claims or causes of action for damages, that all liens, for payment of wages or payment for tools, machinery or supplies of all kinds have been by him entirely liquidated, released and satisfied, and he shall furnish to the Company a clear title to all the work, and to each and every part thereof.

SECTION 16.

16 Subletting or Assignments

The Contractor shall constantly give his personal attention to the faithful prosecution of the work and from the beginning to end shall keep the same entirely under his personal control. He shall not assign or sublet the work, or any part thereof, without previously obtaining the written consent of the Company, nor shall he either legally or equitably assign any of the moneys payable under this agreemeen, or his claim thereto, unless by and with the previous written consent of the Company. He shall punctually pay any and all workmen employed on the work, in current money.

SECTION 17.

17 Time of Commencement and Completion

The Contractor agrees to commence the work within ..... days from the date of execution of this contract, and he agrees to entirely complete, finish and turn over to the Company all of the said work within..... days thereafter, Sundays and legal holidays excepted.

SECTION 18

18 Damages for Delay in Completion

In case the Contractor shall fail to complete the entire amount of work called for in the schedules attached to this contract, within the time specified under Section 17, the Company shall have the right to deduct and retain out of the moneys which may be due, or may become due the Contractor under this contract, the sum of.....dollars per day as liquidated damages for each and every day that the entire work under this contract shall remain uncompleted over and above the time hereinbefore specified in Section 17, Sundays and legal holidays excepted.

SECTION 19

19 Company's Right to Assume Work

If this work or any part thereof shall be abandoned, or if it or any portion shall be sublet or any claim thereunder shall be assigned otherwise than as provided, or if the Engineer or Superintendent shall be of the opinion, and shall so certify in writing to the Company, that the conditions herein specified are not fulfilled, or that the work or any part thereof is unnecessarily delayed, or that the Contractor is violating any of the provisions of this contract, the Company may notify the Contractor to discontinue all work, or any part thereof, and thereupon the Contractor shall discontinue said work, or such part thereof as the Company may designate, and the Company may, by contract or otherwise, as it may determine, complete the work or such part thereof, and charge the expense thereof to the Contractor, and may use therefor any and all materials, animals, machinery, implements and tools of every description as may be found upon the line of said work. The expense so charged shall be deducted and paid by the Company out of any moneys then due, or to become due the Contractor. In case such expense is less than the sum which should have been payable under this contract, if the same had been completed by the Contractor, the Contractor shall be entitled to receive the difference, and in case such expense shall exceed the latter sum, the Contractor shall on demand pay the amount of such excess to the Company.

SECTION 20.

20 Extra Work

The Contractor shall do no work nor supply any materials not herein provided for, unless directed in writing by the Engineer, or Superintendent, and he shall make no claim for any extra work or materials excepting as authorized by the Engineer or Superintendent in writing, and the Contractor shall file with the Engineer or Superintendent a statement of all such extra work or materials, with a copy of the order therefor and a statement of the place where such work or materials were furnished, and shall give an itemized statement of, and vouchers for, the quantities and prices of any and all such work, or material.

SECTION 21.

NO. 1. INSPECTION.

21 Acceptation of Work

Upon the completion of any section of conduit or of any lateral, the Contractor shall notify the Engineer or Superintendent that, in his opinion, the said section of conduit or lateral is complete. Within three days after the receipt of such notification, the Engineer or Superintendent shall inspect such section or lateral, and if he shall find this work has been performed in accordance with the provisions of these specifications, all and singular, and in conformity with any additional plans, or directions, he shall then give to the Contractor a certificate of *Preliminary Inspection.* If the Engineer or Superintendent shall find that in any particular this work does not correspond with the plans, specifications or instructions, he shall notify the Contractor thereof in writing, specifying the defects. The Contractor shall then immediately remove any defective materials or rectify any imperfect construction. When such defective work is removed and replaced with such as is satisfactory to the Engineer or Superintendent, he shall issue to the Contractor a certificate of preliminary inspection.

NO. 2. CONDITION OF FINAL ACCEPTANCE.

On the completion of all the work called for in the schedules attached, and any additions thereto, the Engineer or Superintendent shall make a final inspection of the entire work done and shall measure up all of the quantities of work which have been put in, and the amounts of labor and materials supplied. If this final inspection shall show that all the work is in accordance with the plans, specifications and instructions, and completed to the satisfac-

tion of the Engineer or Superintendent, he shall then render the Contractor a certificate of final acceptance of the entire work, and on receipt of this certificate the responsibility of the Contractor for the work shall cease, and it shall then pass to and become the property of the Company. In case the Engineer or Superintendent shall in this inspection discover any imperfection, he shall notify the Contractor of the same, and the Contractor shall immediately replace any defective work or materials with that which is in accordance with the plans, specifications and instructions, and which is to the satisfaction of the Engineer or Superintendent. The fact that a certificate of preliminary inspection may have previously been rendered to the Contractor for the particular portion on which faulty work or materials is subsequently found, shall not operate to release the Contractor from his obligation at the time of final inspection, to make every part of the work satisfactory in all respects.

SECTION 22.

NO. 1. ESTIMATES.

22 Conditions of Payment

At the end of every calendar month during the progress of this work, the Engineer or Superintendent shall examine and measure up the amount of work performed by the Contractor during the month in question. This examination shall be made within the first five days of each succeeding calendar month, and on the completion thereof, the Engineer or Superintendent shall render to the Company a statement in detail of the amount of work accomplished during the preceding month, and shall give the Contractor a copy of same. Within ten days after the receipt of this statement the Company shall pay to the Contractor.....% of the amount called for in the statement, and shall reserve.....% thereof until completion of the entire work.

NO. 2. FINAL PAYMENT.

Upon the entire completion of all the work called for in the schedules, and any additions thereto, and upon the final examination and acceptation of all the work by the Engineer or Superintendent, and upon full performance of this agreement in all other respects, the Engineer or Superintendent shall render to the Company a statement to this effect, and shall give the Contractor copy of same. Within thirty days thereafter the Company shall make to the Contractor a final payment for all the work herein called for, which shall include all the balances which have been reserved from the preceding monthly payments.

SECTION 23.

23 Prices for Work

The Company shall pay as full compensation for everything furnished and done under this contract, including all damage arising out of the nature of the work, or from the action of the elements, and all risks of every description connected therewith, and for all expenses entailed in consequence of the suspension or discontinuance thereof, the following amounts:

NO. 1. PRICES FOR CONDUITS.

The prices for conduit hereinafter stated shall mean the price per linear foot for conduits containing the varying number of ducts stated in Table A, a different price being given for each number of ducts. The term "Conduit Foot" shall mean one complete linear foot of conduit irrespective of the number of ducts therein, measured along the axis of the conduit, and the length upon which the amounts due the Contractor shall be calculated shall be the length of conduit measured between the inside and adjacent walls of any two adjacent manholes. The following prices shall be full compensation for the removal of the pavement, the excavation of the trench, the placing of the concrete foundation, the laying of the duct

and the supply of the same, the

material re-filling of the trench

without the supply of the same, the

temporary paving,

and the replacement of the and the

permanent paving,

rodding of the ducts as herein specified in Table A.

NO. 2. PRICES FOR CONCRETE MANHOLES.

For each and every standard manhole built of concrete as hereafter specified, and of the general shape and dimensions shown in Plan I attached, including the removal of the paving, the necessary excavation, the supply and manufacture of the mould, the supply, manufacture and placing of the

the supply and placing of the iron cover:

concrete : the

the placing of the iron cover supplied by the Company

re-fillment of the excavation, replacement of the paving and clearing of the street, all as hereing specified, the sum of..... dollars.

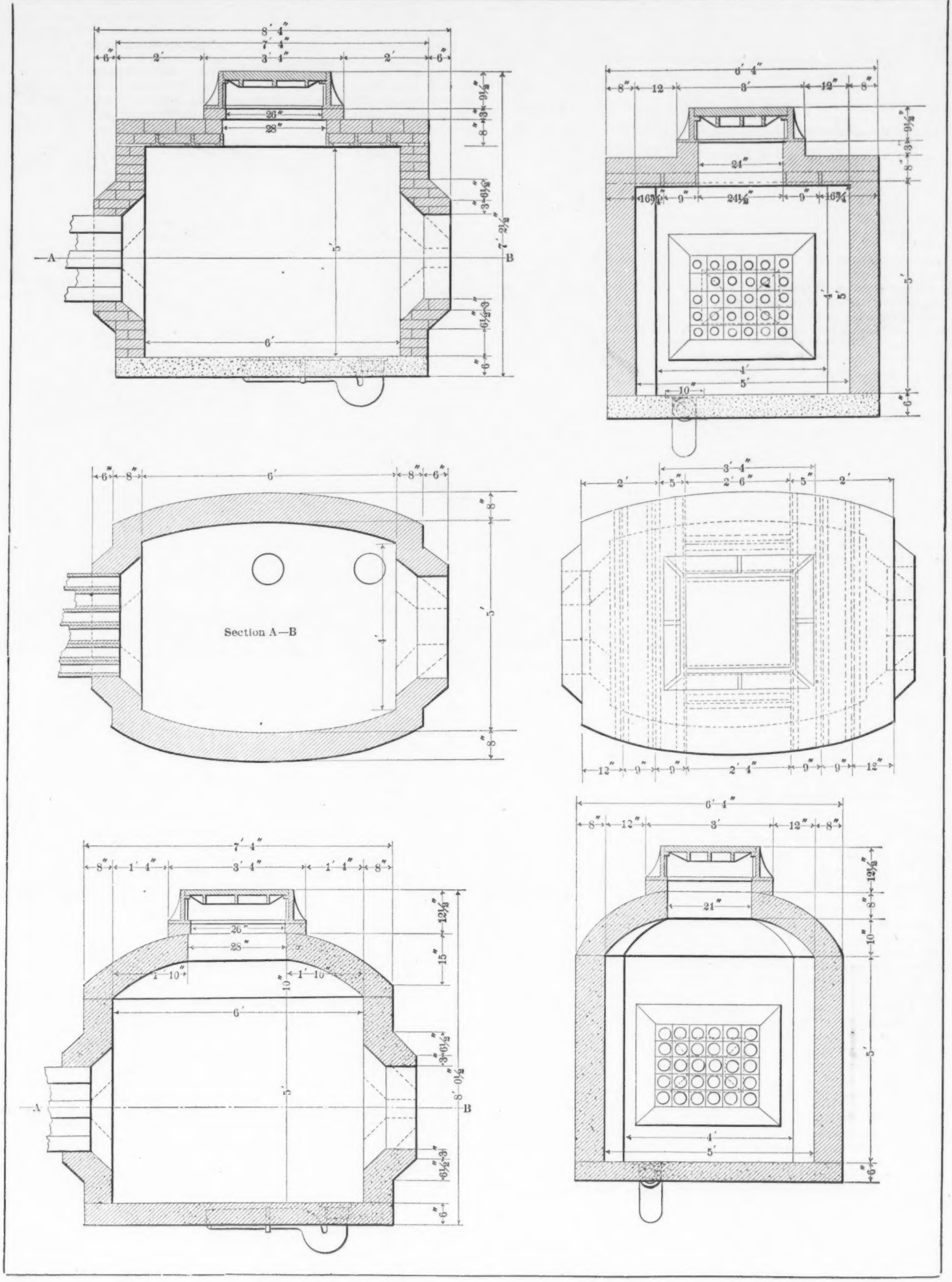
TABLE A.

Contract Prices to be Paid per Conduit Foot.

No. of Ducts.	KIND OF DUCT MATERIAL.						
	Iron Pipe.	Pump Log.	Creosoted Wood.	Cement Pipe.	Hollow Brick.	Multiple Duct.	Paper Tube.
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
18							
20							
22							
24							
26							
30							
36							
48							

NO. 3. PRICES FOR BRICK MANHOLES.

For each and every standard manhole built of brick as hereafter specified, and of the general shape and dimensions shown in Plan I attached, including the removal of the paving, the necessary excavation, the supply, manufacture



STANDARD MANHOLES.

and placing of the concrete for the bottom, all the bricks, mortar, masonry, and labor of laying

the supply and setting of the iron for the roof, and iron cover,

the same the re-

the setting of the iron for the roof and iron cover supplied by the Company

fillment of the excavation, replacing of the paving and cleaning of the street, all as herein specified, the sum of.....dollars.

NO. 4. PRICES FOR SEWER CONNECTION.

For each and every sewer connection made to any manhole, including necessary excavation, the furnishing and laying of sufficient 4-in. tile drain pipe to the sewer, and the connection of the outer end thereof, to the sewer and the inner end thereof to the sewer trap, the furnishing of the sewer trap as specified, including obtaining the necessary sewer permit from the City; the refilling and repaving the excavation, the sum of.....dollars.

NO. 5. PRICES FOR EXTRA WORK.

For all extra labor or materials supplied in accordance with the written instructions, from the Engineer or Superintendent, the Contractor shall charge cost plus 10% (ten per cent.) excepting for such labor or materials as are specified in No. 6.

NO. 6. PRICES FOR SPECIAL EXTRA MATERIALS AND LABOR.

(a) For all extra concrete, including all materials and labor for mixing and placing the same, the price of.....dollars per cubic yard.

(b) For all extra brick work, including the necessary brick work, mortar and labor of laying the same, the price of.....dollars per 1000 brick laid.

(c) For all extra lumber, including the cost of furnishing and placing the same, the price of.....dollars per 1000 fet. board measure.

(d) For all excavation not otherwise included in these specifications, including the removal of the pavement, the rfilling of the excavation, the replacement of the paving, and the cleaning up of the street, the sum of .....cents for each and every cubic yard of actual space excavated.

SECTION 24.

NO. 1. HOLLOW BRICK OR "SINGLE DUCT" MATERIAL.

24 Material Specifications

Hollow brick duct material shall be made of well burnt vitrified clay. There shall be two kinds of pieces—standard pieces and special pieces. All standard pieces shall be not less than 18 in. long. Special pieces shall be 6 in., 9 in., and 12 in. in length, and such a number shall be delivered for each section as may be directed. All pieces shall be either plain square, fluted square, octagonal, or round, in general shape, and joints shall be either butt joints, with or without dowels, or socket joints, as shall be specified for each location.

For butt joints without dowels the outside diameters shall be within reasonable manufacturing limits, 4½ in.; for single dowel joints, 4¼ in.; for socket joints, plain square, or fluted square, 5 in.; for round and octagonal socket joints, 4⅞ in. For all shapes the bore shall be not less than 3¼ in. diameter at any place; shall be truly circular, centered throughout the entire length of each piece, smooth, clean and free from all teats, nodules or rough spots. Butt joints shall have the mouth of each piece at each end reamed to a radius of about ½ in., and each piece shaped true and square with its axis. Dowel joints shall have at least two dowel holes moulded in each end of each piece. These holes shall be accurately moulded and shall match the pins—all of which shall be interchangeable among all pieces. With each piece the requisite number of dowel pins shall be supplied to fill one half the sum of the dowel holes in both ends. Socket end material shall have one end of each piece bell-mouthed, the other chamfered to fill the bell; all pieces shall be mutually interchangeable. Sockets shall be so designed and made that the addition of a little mortar shall make a tight joint and produce a straight uniform cylindrical cable space.

All hollow brick tile shall be of good, finely ground clay, mixed in the proper proportions and burned thoroughly hard clear through. Each piece shall be well vitrified, but shall not be burned so hard as to be fused or scoriated. The surface of each piece both inside and out shall be thoroughly and uniformly glazed with good salt glaze, and shall not contain cracks which extend into the surface more than 1-16 in. Each piece shall be sound, without soft spots, stones, gravel or any other imperfections. Each piece shall be straight, true and fully up to dimensions specified. The bore of each piece shall be tested and shall pass a standard 3 3-16 in. gauge. All pieces which shall have a bow or curve or kink of more than one fourth inch shall not be accepted, and no piece shall be accepted if it shall have any curve in more than one plane. All hollow brick tile shall be examined by an inspector appointed by the Company at such a place as shall be directed, and only such pieces accepted as shall fulfill all of these specifications. If required, the Contractor shall scrape or clean each piece through the inside of the bore by an appropriate scraper or cleaner, which shall be subject to the approval of the Engineer or Superintendent. All damaged or rejected pipe shall be removed by the Contractor.

NO. 2. MULTIPLE DUCT MATERIAL.

Multiple duct material shall comply with all the provisions of Section 24, No. 1, so far as quantity of material, size and location of bore, dowels, etc., and shall be of the general dimensions shown in Table B, depending on the number of cable spaces.

TABLE B.

DIMENSIONS OF MULTIPLE DUCT PIECES.

THREE INCH DUCTS.

Number of Ducts.	Height and Width of End Section in Inches.	Standard Lengths in Inches.	Special Lengths in Inches.	Approx. Weight per Duct Foot.
Two Duct.....	4⅝x 8¾	24	6 and 12	8¾″
Three Duct.....	4⅝x13	24	6 and 12	8½″
Four Duct.....	3¾x 8¾	36 and 48	6, 9 and 12	8″
Four Duct.....	4¾x17	24	6 and 12	8″
Six Duct.....	8¾x13	36 and 48	6, 9 and 12	8″
Nine Duct.....	13 x13	36	6, 9 and 12	7¼″
Twelve Duct....	13 x17	30	6, 9 and 12	7¼″
Sixteen Ducts...	17 x17	30	6, 9 and 12	7¼″

NO 3. CEMENT LINED PIPE DUCT MATERIAL.

The dimensions of each piece of cement lined pipe shall be: length not less than 6 ft.; diameter of bore not less than 3 in.; the thickness of cement not less than ½ in.; the thickness of the iron casing, N. 24 B. W. G. Each piece shall be of uniform section, with bore concentric with shell, straight and truly circular throughout its length. The iron casing shall be of good iron, riveted with ⅛ in. rivets set 1½ in. on centers, and painted on the outside with the best quality of coal tar paint, asphalt or other approved coating material applied hot. The lining shall be of pure first-class hydraulic cement without admixture of sand or any foreign material, which shall be applied a sufficient time before shipment to become thoroughly set and sufficiently strong to bear transportation. The cement used for lining shall be an approved quality hydraulic cement, and if required the results of tests for fineness and tensile strength, made as specified in Section 24, No. 7 a, shall be submitted to the Engineer or Superintendent for approval. Pipe made from unapproved materials may be rejected. Each piece shall be supplied with approved cast iron, socket ends thoroughly and securely attached, of such design as shall make a concentric tight joint. Each and every piece shall be free from cracks, indentures, teats, nodules, depressions, breaks or rough surfaces of any kind; shall be straight, true and full to all dimensions; and shall not have a bow or curve of more than ½ in. in any plane; and no bend in more than one plane. All pipe snall be cleaned and inspected at such places as may be directed.

NO. 4. CEMENT PIPE DUCT MATERIAL.

Cement pipe shall have an outside diameter of not less than 4⅞ in., and inside diameter of not less than 3⅜ in., and a thickness of not less than ¾ in. It shall be made of a mixture of first-class Portland Cement, and fine crushed stone pressed into an appropriate form. The cement shall be an approved quality of Portland cement, and if required the results of tests for fineness, tensile strength, etc., made as specified in Section 24, No. 7, a, shall be submitted to the Engineer or Superintendent for approval. Pipe made from unapproved materials may be rejected. Pipe shall be supplied in lengths of not less than 6 feet, straight, true and fully up to dimensions in every respect, with no bend of more than ½ in., and no bend in more than one plane. The inner surface shall present no lumps or roughnesses or be in any way injurious to the cable sheath. The inner edge of each end of each piece shall be rounded to a radius of at least ½ in. Pipe shall have been made a sufficient length of time to be amply strong to bear hauling without breakage. The pipe shall be fully equal in quality to that of the standard sample which shall be deposited with Engineer or Superintendent prior to the award of this contract.

NO. 5. CREOSOTED WOOD DUCT MATERIAL.

a. Pump Logs, Square and Round.

Creosoted wood duct material shall be made of first class, thoroughly seasoned, white or yellow pine. Each piece shall be not less than 4 ft. in length

and 4½ in. x 4½ in. outside for square log, and not less than 4¾ diameter for round log. The sides of each piece of square log shall be at right angles to each other, smooth and true. Round logs shall be turned smoothly and truly from end to end throughout the center of each piece. There shall be a bore fully 3 in. in diameter accurately centered and truly circular. At one end of each piece there shall be a tenon 1¾ in. long and not less than 3½ in. outside diameter. On the other end of each piece there shall be a mortise not less than 1¾ in. deep and a snug fit for each tenon, but this fit shall not be so tight as to cause the wood to split when successive pieces are driven together. All pieces shall be interchangeable. After the pieces are milled they shall be creosoted by the following process:

1st. The lumber shall be steamed in a closed tank with steam at not less than 45 lbs. gauge pressure for at least four hours.

2nd. A vacuum of at least 20 in. shall be applied to the tank and the drainage of sap from the timber pumped away. This vacuum shall be continued as long as any sensible drainage of sap or moisture is discharged by the pump.

3rd. Pure dead oil of tar shall be pumped into the cylinder and an hydraulic pressure applied sufficient to force into the timber at least 14 lbs. of oil per cubic foot of timber in the charge. The absorption of the oil by the timber shall be determined by measuring the total quantity of oil pumped into the treating cylinder and comparing this quantity with the difference between the volume of the cylinder and the volume of the charge under treatment.

4th. All oil used in treatment shall be pure deal oil of tar and shall be subjected to a chemical analysis and proved to contain no deleterious substances. It shall possess the following characteristics:

a. It shall be completely liquid at a temperature of 100° F.

b. It shall contain at least 25% of constituents that do not volatilize at a temperature of 600° F.

c. It shall not contain over 5% of tar acids.

d. It shall contain no admixture of any substance not obtained from the distillation of coal tar.

5th. After creosoting is conmpleted all duct material shall be allowed to season at least three months in the open air before being laid.

b. Valentine Conduit.

All lumber used for Valentine conduit shall be of the same quality and treated in the same manner as specified under Section 24, No. 5 a.

The following Table C specifies the cross scetional dimensions of the woodwork for 1½ in., 2 in., 2½ in. and 3 in. ducts:

TABLE C.

VALENTINE DUCT MATERIAL.

Sizes of Conduit.

1½ INCH CONDUIT.

Conduit containing	1	ducts,	dimensions	3	x 3
" "	2	"	"	3	x 5¼
" "	3	"	"	3	x 7½
" "	4	"	"	5¼	x 5¼
" "	6	"	"	5¼	x 7½
" "	9	"	"	7½	x 7½
" "	12	"	"	7½	x 9¾

2 INCH CONDUIT.

Conduit containing	1	ducts,	dimensions	3½	x 3½
" "	2	"	"	3½	x 6¼
" "	3	"	"	3½	x 9
" "	4	"	"	6¼	x 6¼
" "	6	"	"	6¼	x 9
" "	9	"	"	9	x 9
" "	12	"	"	9	x 11¾

2½ INCH CONDUIT.

Conduit containing	1	ducts,	dimensions	4	x 4½
" "	2	"	"	4½	x 7¾
" "	3	"	"	4½	x 11
" "	4	"	"	7¾	x 7¾
" "	6	"	"	8	x 11
" "	9	"	"	11	x 11½
" "	12	"	"	11	x 15

3 INCH CONDUIT.

Conduit containing	1	ducts,	dimensions	5	x 5
" "	2	"	"	5	x 8¾
" "	3	"	"	5	x 12½
" "	4	"	"	8¾	x 8¾
" "	6	"	"	8¾	x 12
" "	9	"	"	12½	x 12½
" "	12	"	"	12½	x 16¼

Wood slabs shall be supplied in lengths of not less than 8 ft. The top and bottom slab shall be plain and free from grooves on the upper and under sides respectively. Along each edge of each piece outside the outer cable space a groove shall be cut into which a dovetail shall be fitted capable of making a tight joint with the succeeding slab. All dovetails and grooves shall be accurately and carefully milled and all pieces shall be mutually interchangeable in such a manner that when assembled all cable spaces shall be truly round and circular and in their proper mutual relative position.

NO. 6. WROUGHT IRON PIPE DUCT MATERIAL.

Wrought iron pipe duct material shall be of good quality of wrought iron or mild steel, known as casing pipe. The pipe shall be supplied in lengths of..... .....ft., weighing about four pounds per lineal foot, having a thickness of about ⅛ in., and shall be supplied with a right hand male screw thread at each end. Each piece shall have fully 3 in. on the inside diameter, and be smooth, true and round in every respect. Pieces having fins, cold shuts, nodules, bad welds or rough places upon the inside, or containing kinks, bends or imperfections of any kind, shall be rejected. The end of each piece shall be cut true and square with the axis and reamed out to free it from any fins or projecting slivers. The thread upon each shall be standard casing pipe thread, 14 to the inch, truly and smoothly cut and at right angles to the axis. One end of each piece shall be supplied with standard casing pipe socket threaded through to fit the pipe. Each piece shall be thoroughly painted inside and out with two coats of tar paint, asphalt or other approved coating material applied hot.

NO. 7. CEMENT.

For all concrete and mortar, an approved quality of cement shall be applied; all cement shall be subjected to the following tests and conditions.

(a) Method of Testing.

Before using any cement the Contractor shall submit to the Engineer or Superintendent samples of any brands which he proposes to employ, and if at any time the Contractor wishes to change the kind of cement, he shall again submit a sample for inspection. Each sample shall contain about 50 lb. and from each sample a sufficient quantity shall be taken to make ten lots of briquettes, each lot containing ten briquettes, of American Society of Civil Engineers standard. The first lot of ten briquettes shall be mixed with 15% of water by weight, the second lot with 16%, the third with 17%, the fourth with 18%, the fifth with 19%, the sixth with 20%, the seventh with 21%, the eighth with 22%, the ninth with 23%, and the tenth with 24% of water. Briquettes shall be made by thoroughly mixing each weighed quantity of water with the weighed quantity of neat cement and ramming into briquette moulds. When sufficiently set, briquettes shall be placed under a damp cloth and kept for twenty-four hours from the time of mixing. Then each lot shall be broken by tension in a standard cement testing machine. The amount of water used with the lot developing for the average of the entire ten the greatest tensile strength shall be taken as the proper quantity of water for mixing with the brand of cement in question. All subsequent tests on this brand shall be mixed with the same per cent. of water. From every lot of cement delivered upon the work, the Engineer or Superintendent shall sample such a number of bags, barrels or packages as shall in his opinion be sufficient to determine the quality of the entire lot. If only 60% of these samples tested as above specified shall average 250 pounds per square inch, the lot of cement from which these samples came shall be rejected. If 70% of these samples shall reach 250 pounds, this lot of cement may be either rejected or re-tested, as the Engineer or Superintendent shall see fit. If over 70% shall reach 250 pounds per square inch, the lot shall be accepted.

(b) Fineness Test.

Each lot shall be tested for fineness, by sifting a weighed portion through a No. 100 sieve, or one containing 10,000 meshes per square inch. At least 90% of each sample shall pass the sieve.

(c) Setting Tests.

Each lot shall be tested for setting mixed with 5% more water than in the specification for tensile test. Three minutes after the application of the water, a Gilmore needle, namely, wire 1-12 in. in diameter and loaded with ¼ pounds, shall be placed on the mixed sample and the length of time and the distance the needle penetrates noted. All samples shall allow the needle to penetrate for at least one minute, and for at least one inch.

(d) Storage.

All cement shall be delivered in original packages bearing the mark, brand or designation of the maker. The Contractor shall store cement in such a way as to keep it free from injury by weather. All barrels, bags or packages shall be raised from the ground upon suitable supports, and at all times covered with waterproof covering. If the Engineer or Superintendent shall suspect that any cement has been injured, he may condemn same. When any cement has been

rejected, the Contractor shall within 24 hours thereafter remove same, and during the said 24 hours he shall take suitable precaution to prevent the rejected cement being used. If the Engineer or Superintendent believes that rejected cement has been used, he may order such work to be taken out and replaced with that made with accepted cement.

(f) Rate of Delivery.

The Contractor shall at all times provide such a supply of cement as shall give a sufficient quantity to use for at least 48 hours in advance of any additional deliveries, to allow sufficient opportunity for tests, and in case the Contractor shall not provide sufficient cement to allow the specified 48 hours the Engineer or Superintendent shall summarily stop the work until a sufficient quantity of cement shall be delivered ahead to allow of 48 hours for testing. For any stoppage of work of this kind the Contractor shall make no claim for delay, and such failure to deliver cement shall not release the Contractor from liability for non-completion, as in Section 18.

NO. 8. SAND.

All sand shall be first-class fine, sharp, silicious sand, preferably beach, river or lake sand or fine crushed stone, which is not worn or washed. All sand shall be free from loam, dirt, mica, scales, dust or other foreign matter, and when tested by shaking in water it shall not show more than 1% of suspended matter. Sand shall be tested by sifting samples, and at least 75% shall pass a No. 16 sieve and be retained by a No. 40. Previous to the commencement of the work the Contractor shall submit a sample of sand which he proposes to use. If this sample be approved it shall be retained by the Engineer or Superintendent. All sand used on the work shall correspond with the sample.

NO. 9. BROKEN STONE.

All broken stone shall be a first-class quality of granite, gneiss, trap or limestone. It shall be broken to have sharp and irregular angles and shall pass in all directions through a 1½ in. ring and also be screened to romove dust. Broken stone shall be clean and free from sand, loam or other admixtures. The Contractor shall submit a sample of broken stone, and if approved the Engineer or Superintendent shall retain the same. Stone subsequently delivered shall correspond to the sample.

NO. 10. BRICK.

All brick shall be first-class hard burned sewer brick, fully up to all dimensions, true and square, with all the faces at right angles, sharp clean edges, thoroughly hard burned clear through. All brick shall be free from bats; broken bricks, light hards or other imperfect brick, shall be thoroughly culled before being delivered, be uniformly and evenly burned. The Contractor shall submit to the Engineer or Superintendent samples of brick, which if approved shall be retained, and all brick shall correspond to the sample.

SECTION 25.

NO. 1. TEST HOLES.

(a)

25 Construction Specifications

If required the Contractor shall dig not to exceed one (1) test hole for every running block of street along the line of the proposed conduit. These holes shall be dug to any depth not to exceed ten feet (10 ft.), and of any width not to exceed three feet (3 ft.), and of any length not to exceed the width of the street. The Contractor shall make no extra charge for any such test holes, but if more than one test hole per linear block is requested, or if the dimensions shall be greater than those specified, the Contractor shall be entitled to extra compensation for all excavation over this amount.

(b) Notice to Commence Work.

For each and every section of conduit, for each manhole and for each lateral, the Engineer or Superintendent shall give to the Contractor a written notice, stating the time at which he shall commence work upon the section, manhole or lateral in question.

(c) Size of Excavation.

All trenches or excavations shall be dug of such size and to such depths as shall in the opinion of the Engineer or Superintendent give suitable and adequate room for the structures they are to contain. On the average, trench for conduit must be about 2 ft. in width by 4 ft. in depth, and excavations for manholes about 6 in. greater in dimensions than those of the vault upon Plan I, but in order to provide for the possibility of unforeseen street obstructions, the Engineer or Superintendent may direct the Contractor to open any trench for conduit, of any width up to 3 ft., and of any depth to 5 ft., measured below the street paving, and may direct for any manhole an excavation not to exceed 3 ft. greater in length and 2 ft. in breadth than the dimensions above specified, and of a depth not to exceed 10 ft. measured below the street paving. For laterals a trench 18 in. wide and 2 ft. in depth will usually suffice, but the Engineer or Superintendent may require the Contractor to open the trench not to exceed 2 ft. 6 in. in width and 4. ft. in depth. For any and all such excavation the Contractor shall make no extra charge. In case the Engineer or Superintendent shall require the Contractor to open any trench or any excavation which is greater than the dimensions herein specified, he shall give the Contractor a written order for such extra excavation which is over and above in amount herein called for, and this order shall authorize the Contractor to make the specified extra amount of excavation at the prices for extra work of Section 23, No. 6 d.

NO. 2. WAY IN WHICH EXCAVATION SHALL BE MADE.

On receipt of notice to commence work, together with directions giving the location and size of the excavation, the Contractor shall remove the paving along the line specified and shall dig the excavations in accordance with the dimensions given. For each section the Contractor shall open the trench completely from one end to the other, including the manhole excavations at each end thereof, and shall carry all excavations completely down to the specified depth.

Upon the removal of the paving, the Contractor shall pile same neatly along the line of trench or shall make any other disposition of same as may be directed. He shall pile the excavated material along the side of the trench, provided the same can be done without unreasonable interference with traffic, but in crowded localities or if directed by the Engineer or Superintendent, the Contractor shall remove any and all excavated material whatsoever from the line of the trench, leaving the street free and clear, with the exception of the actual opening. The Contractor shall preserve all the material excavated, and shall use the same for refilling and repaving as shall be directed.

The Contractor shall make all the requisite excavations as herein provided, in whatever materials, wherever found in the streets. If the Contractor shall encounter any rock, old masonry, walls, concrete, hard pan or other material, he shall make the excavation in same without extra charge. If the nature of the material is such as to require blasting, the Contractor shall conduct any and all such operations strictly in accordance with all city rules and regulations therefor. He shall use the minimum amount of explosive for the purpose, and in all cases blasts shall be carefully protected to prevent injury by flying debris. He shall use the most approved appliances and skilled labor which shall conduce to the safety of the public and of his employees in every manner whatsoever. The Contractor shall do all pumping and bailing necessary to keep the trench free from water and in proper condition to receive the ducts. He shall do all sheeting, bracing, shoring or supporting, and shall keep all excavations dry during such time as may be required for the proper setting of all concrete or masonry, all fencing and all other things, needful to constantly protect and maintain the sides and safety of the excavation, and to care for all gas pipes, water pipes, sewers, drains, electric conduits, railways or other structures encountered, and shall maintain and protect all buildings, railways and other structures which may be found during the progress of the work. He shall further provide all crossings and bridges which may be necessary to maintain travel uninterruptedly on all streets and alleys, and shall guard and watch all excavations in complete accordance with all the rules and regulations of the City of.....or any directions which may be in future given by the City authorities or the Police Department. At night all excavations shall be properly fenced, lighted and guarded to insure the safety of the public. During the progress of the work, any gas pipes, water pipes, sewers, drains, electric conduit, catch basins, buildings, railways or other structures which may be uncovered or undermined by the Contractor shall be restored and left by him in equally good condition, or if injured or harmed in any way, shall be replaced by him without extra compensation therefor, in as good condition as that in which they were found. During the progress of the work all supplies, materials, tools and machinery shall be neatly distributed along the line of the street to least obstruct the traffic or if directed the Contractor shall store all material, tools, machinery or supplies off the line of work, and in all cases particular care shall be given to providing free access to water hydrants and shut-offs and to arrange for free passage ways for the Fire Department. Upon the completion of any section of conduit, manholes or laterals the Contractor shall remove therefrom any sheeting, shoring or bracing which may have been introduced for the purpose of holding the sides of the trench or maintaining any street structures, unless the Engineer or Superintendent shall direct the Contractor in writing to leave same in place. If the Engineer or Superintendent shall elect to leave any sheeting, shoring or bracing in place, he shall give a written order to the Contractor authorizing such as extra materials and work, with extra compensation therefor, as per Section 23, No. 6, c.

NO. 3. FINAL ALIGNMENT AND GRADE OF EXCAVATION.

Upon the completion of any excavation to the dimensions specified, the Contractor shall notify the Engineer or Superintendent that he is ready for final line and grade. The Engineer or Superintendent shall then drive one stake at each end of the excavations for the manholes, and one stake along the line of conduit at intervals of about ten feet. In manhole excavations stakes shall be so driven as to locate the center of the manhole, while the top of the stakes shall be at the grade of the top of the bottom thereof. In the trench the stakes shall give the center line of the conduit, the top of the stakes indicating the top of the concrete foundation. In all cases the exact center line shall be indicated by a tack driven in the top of the stake. As soon as the stakes have been

driven, the Contractor shall trim the sides and the bottom of the trench, in such a manner as to give adequate room to place the structures.

The Contractor shall make no extra charge for the final trimming or any excavation which may be necessary to bring the excavation to the proper line and grade, as given by the final stakes. In case the opening of any excavation shall disclose any obstacles that render it advisable in the judgment of the Engineer or Superintendent to change either line or grade or both, he shall have the right to make any and all such changes as he may see fit, and in so far as any such changes do not require the Contractor to open excavation of greater dimensions than called for in Section 25, No. 1, c, no extra charge shall be made. In case the grade of the conduit shall be raised, and if the Engineer or Superintendent shall order the concrete foundation to be increased in thickness to accommodate such change, he shall give the Contractor an order for all extra concrete required over and above the amount hereinafter specified for foundations. But in case such change in grade shall be made by refilling and material excavated, no claim shall be made by the Contractor for any extra work for such change.

NO. 4. OBSTACLES.

Whenever it shall become necessary to change the location, either temporarily or permanently, of any water pipes, gas pipes, sewers, drains, electric subways, electric mains, catch basins, railways or other structure encountered the Contractor shall send notice of the existence of any such obstacles to the Engineer or Superintendent, and if in his judgment such changes are deemed necessary, he shall notify the owners or those in charge of such structures, and any and all changes shall be effected in accordance with the directions and under the supervision and subject to the approval of such owners or persons in charge. In case the Engineer or Superintendent shall call on the Contractor to do any of the work of the removal or changes in any street obstructions, the Contractor shall supply any and all work, labor, tools, appliances or material such as shall in the opinion of the Engineer or Superintendent be desired for this purpose. All such labor, work, tools or materials shall be the subject of an order for extra work, which shall be given to the Contractor by the Engineer or Superintendent in advance of the performance of the work, at the prices specified in Section 23, Nos. 5 and 6. For all time which in the opinion of the Engineer or Superintendent the Contractor is delayed by the non-removal of any street obstructions, the Contractor shall be allowed a corresponding number of extra days' time over and above that herein stipulated for the completion of the entire work called for by this contract. If in the opinion of the Engineer or Superintendent any such time allowance is due, he shall give to the Contractor a certificate of extra time allowance, specifying the number of days.

NO. 5. MORTAR.

All mortar, either for concrete or for masonry, shall be mixed as follows:

A sample of the sand shall be tested to determine the percentage of voids by filling a measured vessel having a capacity of about 1 cubic foot, and then adding as much water as possible without causing the vessel to overflow, and noting the amount which shall be deemed a measure of the voids. To prepare mortar such an amount of packed cement shall be taken as is equal to 125 per cent. of the amount of voids thus shown and thoroughly mixed with sand. Enough water shall then be added (approximately one-third of the cement) and the whole mass thoroughly mixed. After proportions are thus determined the relative quantities of cement, sand and water, as thus shown, shall be used in all work. The relative proportion of water, cement and sand will be about one third part of water, one of cement and two and one half of sand, for such cement and sand as is hereinbefore specified. The proportions thus given are only approximate, and as they will vary with the different kinds of sand and cement which may be used, the exact proportions in each case shall be determined by the Engineer or Superintendent.

NO. 6. CONCRETE.

The voids in broken stone used for concrete shall be determined as previously specified for voids in sand. After the amount of voids is ascertained, a proportion of cement mortar made as specified in Section 25, No. 5, equal to 140 per cent. of these voids shall be used. With the cement, sand and stone previously specified, the proportions for concrete will be one third part of water, one part of cement, two and one half parts of sand and seven and one half parts of broken stone, but as the character of the broken stone may vary from time to time, the proportion of voids for each kind of stone used shall be measured, and the Contractor shall mix concrete in accordance with the instructions given by the Engineer or Superintendent after such determination.

NO. 7. MIXING.

All cement-mortar and concrete shall be made by accurately measuring—not estimating—the proportions of the various ingredients of which they are composed, as directed, by the Engineer or Superintendent. Mixing shall always be done on a mixing board or trough or by a mixing machine—never on the ground. For mortar the proper proportions of cement and sand shall be measured and thoroughly mixed by shoveling over five times, then—not previously—shall the proper proportion of water be added and the mass again mixed by shoveling at least five times. Concrete shall be mixed by adding the specified quantity of mortar to the specified quantity of stone and shoveling at least five times. Mortar shall not be used that has been mixed for more than thirty minutes, and no concrete that has been mixed for more than forty-five minutes. No retempering or the addition of any material whatsoever to either the mortar or concrete shall be permitted after mixing has commenced.

NO. 8. METHOD OF LAYING DUCT MATERIAL.

(a) Hollow Brick or Single Duct Material; Butt Joints without Dowels.

The Contractor shall place upon the bottom of the trench a layer of concrete 3 inches thick to form the foundation. This layer shall be deposited uniformly and evenly, carefully levelled and scraped so that it shall present a uniform even surface, both longitudinally and transversely to line and grade. The concrete shall be thoroughly packed into place with suitable rammers not less than 6 inches square, weighing not less than 25 pounds, rammed until its surface slightly flushes, and on completion the foundation shall be level and even with the top of all grade stakes. After the concrete is placed, at least six hours shall be allowed for setting before any duct material is laid thereon, unless in the opinion of the Engineer or Superintendent the immediate placement of the conduit is necessary. If the Engineer or Superintendent shall direct the Contractor to place the conduit immediately, the Contractor shall protect the top of the concrete with sufficient planking so that it may not be injured. The duct material shall be laid by placing upon the surface of the concrete foundation a thin coating of cement mortar about ¼in. in thickness, and the first layer containing the number of ducts horizontally specified in the directions of the Engineer or Superintendent shall be placed upon this bed of mortar and laid by line and level. As each piece is laid all of its sides shall be coated with cement mortar to form a solid joint with each neighboring piece, and at the same time the ends of each piece shall be similarly coated to make a sealed joint; no joints shall be laid dry or flushed. All hollow brick shall be laid upon a mandrel, not less than three inches in diameter and five feet in length, excepting in cases of curves where a mandrel three feet in length may be employed. The front end of this mandrel shall be supplied with a ring whereby the mason by means of a long hooked rod can draw it along, and the rear end with a washer of leather or rubber lightly fitting the ducts, the object of which is to scrape away any mortar that may accidentally enter. All hollow brick shall be laid so as to break joints in every direction, both longitudinally and vertically.

As soon as the first few feet of the lower layer of ducts are laid, a second layer shall be started and shall proceed simultaneously with the first, being laid to line and level. The laying shall proceed in a similar manner until such a number of horizontal layers is placed as is called for by the specifications for the particular section.

In laying pipe, care shall be taken to so place each piece that the bend, if any, shall be in a vertical plane. All sections of conduit shall be laid perfectly straight to line and grade, unless by special directions from the Engineer or Superintendent. In case it shall become necessary to make any curves, either vertical or horizontal, the Engineer or Superintendent shall lay out all such curves, and the Contractor shall then lay the duct material exactly to the lines given. If necessary the Engineer or Superintendent may require the Contractor to provide a templet to insure accurate laying.

(b) Hollow Brick or Single Duct Material, Butt ends with Dowels.

When dowel butt ends are used all the requirements of Section 25, No. 8. a. shall be observed exactly as therein specified, and in addition after each piece is laid a dowel pin shall be inserted into each of the dowel holes in the open end thereof, and the succeeding piece centerd by these pins. The use of a laying mandrel shall be omitted.

(c) Hollow Brick or Single Duct Material—Socket ends.

When socket ends are used all the requirements of Section 25, No. 8. a. shall be observed, and in addition special care shall be taken to coat the male end of each piece uniformly and thinly with mortar, and to drive it into the female end of the succeeding piece. The use of a laying mandrel shall be omitted.

When socket ends are used, all the requirements of Sec. 25, No. 8 a shall be observed, and in addition special care shall be taken to coat the male end of each piece unifromly and thinly with mortar, and to drive it firmly home with the female end of the preceding piece: With dowel or socket ends the use of the mandel in laying may be omitted, if so direct by Engineer of Superintendent.

(d) Multiple Duct Material.

Multiple Duct Material shall be laid under the provisions of Section 25, No. 8. a. except that no mortar shall be used between the ends of each piece, but instead each joint between successive pieces shall be made by wrapping a strip of burlap 12 in. wide and long enough to make 2½ complete turns around the ends of the piece to be jointed. Prior to wrapping the burlap shall be dipped into melted asphalt, as hot as possible without danger of burning the burlap, and applied hot to the duct material. No laying mandrel shall be used with multiple duct material.

(e) Cement Lined Pipe.

Cement lined iron pipe shall be laid by providing concrete foundation as already specified in Section 25, No. 8. a. Upon this foundation the cement lined iron pipe shall be laid in a manner similar to that specified under Section 25, No. 8. a. and c., but in addition sufficient mortar shall be used to fill completely all of the voids between each round piece of pipe and any and all of its neighbors. No mandrel shall be used.

(f) Creosoted Wood—Pump Log.

Creosoted wood duct material shall be laid without any foundation or encasement of concrete. After the trench is excavated the bottom shall be rammed solidly to compact it and then shall be levelled off and graded in the same manner as specified for the concrete foundation. The creosoted wood duct material shall then be laid upon the bottom of the trench to line and grade, as specified in Section 25, No. 8. a. and c., excepting that no mortar, cement or concrete shall be used. Previous to joining the pieces the tenon of each piece shall be painted with hot asphalt and then driven solidly home into the mortise of the preceeding one. At each joint one stake 1¼ in. thick and 3 in. wide shall be driven into the bottom of the trench close to and on each side the duct material to hold the same in place. These stakes shall be of such a length as to be driven into solid material. The top of these stakes shall be driven flush with the top layer of ducts and then shall be secured by a cross batten of 1¼ in. creosoted lumber 3 in. wide, secured to each stake by two wire nails three in. in length. The lumber and nails for the stakes thus specified shall be included in the term "Duct material."

(g) Iron Pipe.

Iron pipe duct material shall be laid in the same manner as specified for cement lined pipe Section 25, No. 8 e, excepting in the case of laterals when the concrete encasement shall be omitted.

(h) Cement Conduit.

Cement conduit shall be laid as specified for cement lined pipe, Section 25, No. 8 e, but in addition shall be laid on a mandrel.

(i) Laterals.

Laterals shall be made of any form of duct material, as may be directed by the Engineer or Superintendent, and each lateral shall be laid in the same manner as is specified for the duct material of which it is composed, except that the concrete foundation and encasement shall be omitted. One end of each lateral shall commence at some distributing point, such as the terminal pole of an aerial line, or on the inside wall of a building. The other end of each lateral shall terminate in some manhole or in some duct of the conduit.

NO. 9. ENCASEMENT.

After all the duct material is laid in any section, a period of not less than six hours shall be allowed for mortar to set before the concrete encasement is put in, unless the Engineer or Superintendent shall direct the Contractor to proceed immediately therewith. The concrete encasement shall consist of a layer of concrete two inches in thickness on each side of the ducts and three inches on the top, so that when joined to the foundation it shall form a complete enclosure for the conduit. This concrete shall be deposited, on each side of the conduit, and on the top thereof, and carefully rammed into place, great care being exercised not to injure or break any of the joints of the duct material. After the concrete encasement is placed, a period of six hours shall be allowed for the setting thereof, before the trench is refilled, unless the Engineer or Superintendent shall direct immediate refillment.

NO. 10. REFILLMENT OF TRENCH.

The contractor shall refill into the trench the material previously excavated. This material shall be refilled in layers not to exceed 6 in. in thickness, carefully deposited on and around the concrete, in such a manner as not to injure the bond thereof and each successive layer shall be thoroughly and carefully rammed into place with rammers similar to those specified for ramming concrete. If required, the Contractor shall puddle any and all refill. Upon the completion of each section of conduit and each lateral, the Contractor shall at once thoroughly and carefully clean up the street and sidewalks. He shall remove all surplus dirt, paving material and all tools, materials and supplies of whatever nature and description, and in every respect except the strip of paving removed, the street shall be restored to as good condition as before the opening was made, and shall meet the approval of the city authorities in all particulars.

NO. 11. TEMPORARY PAVING.

(a) As soon as the refillment of the trench is completed, the Contractor shall restore the paving in such a manner as to make the streets safe and suitable for traffic. If any of the cross walks, paving blocks or other paving material has become lost or injured or is in any way unsuitable for this purpose, the Contractor shall supply, at his own expense, a sufficient amount of suitable paving material to make good the street. In this replacement of paving the Contractor shall not be required to make finished and permanent repaving, but shall merely replace in such a manner as is necessary to allow for the refill to settle and compact itself sufficiently to warrant permanent repaving.

(Cancel paragraph b. if paving is done by conduit contractor.)

(b) It is further specified that on the replacing of the pavement in the temporary manner thus specified, the work of the Contractor upon this section of the conduit in so far as the street paving is concerned shall cease, and that the future and final repaving of the same in a manner suitable and acceptable to the city authorities shall be done by the Company.

(Cancel No. 12. a. paragraph if paving is done by Company.)

NO. 12. PERMANENT REPAVING.

(a) After the temporary paving, as specified in Sec. 25, No. 11. a., is done the Contractor shall allow such a time as may be directed by the Engineer for the settlement and compacting of the refill before permanent repaving. When this time has elapsed, the Contractor shall repave all excavations with the same class of paving materials as have been removed. All curb stones, gutter stones, flagstones or sidewalks, and all street paving material which may have been displaced shall be put back in as good or better shape than before the removal. In all paving work the standard specifications or requirements of the City of ———— shall be followed and when the final paving is complete the street shall be finished, cleaned and left in as good, or better, condition than before the openings were made, and shall in every particular meet the approval of the City authorities.

(b) In all excavations the Contractor shall exercise due care not to move or disturb the pavement in excess of that required for the opening specified, and shall be responsible for any and all paving which is disturbed or moved, that is more than six inches away from the line of the excavation as laid out by the Engineer, and in the event of the disturbance of any pavement beyond the six inches herein specified, the Contractor shall replace all such moved or disturbed pavement at his own expense.

If, within a period of one year after the final repaving of any opening, any settlement, heaving or displacement of any of the paving, curb stones, gutter stones, cross walks or side walks shall occur, the Contractor shall repair and make good the same in a manner satisfactory to the city. And to meet the cost of any such repair work, it is hereby agreed that an amount not to exceed 25 per cent. of the estimated cost of paving permanently the whole surface of pavement disturbed by the work specified in this agreement shall be withheld by the Company from any amount which may become due to the Contractor on account of this contract, for a period of one year after the entire completion of the work. And that during said period of one year the Company shall notify the Contractor of any repairs or repaving which may be necessary on account of said work, and the Contractor shall at once, on receipt of such notice, make any and all such repairs, in a manner satisfactory to the city. If the Contractor shall fail upon receipt of such notice to make the repairs therein stipulated within such a time as shall be required by the City, the Company may make the necessary repairs and may deduct the cost of such repairs from the amount held as herein specified. At the expiration of one year from the entire completion of the work herein called for, and upon the completion of any and all repairs to any and all portions of the streets which may have been opened for the construction of the work herein specified in a manner satisfactory to the City, the Company shall pay to the Contractor any and all moneys which may remain over and above the cost of said repairs, from the amounts withheld as above specified.

NO. 13. CONSTRUCTION OF MANHOLES.

(a) Brick Manholes.

The bottom shall consist of a layer of concrete 6 in. in thickness, large enough to cover the entire area of the manhole and extend under the walls thereof, as shown upon Plan I. This concrete shall be mixed in the proportions and deposited as specified in Sec. 25, No. 6. After the concrete bottom is in place at least 6 hours shall be allowed for setting before the masonry is commenced, and the Contractor shall protect the surface of the concrete by suitable planking and then shall proceed with the walls, which shall be built essentially as shown on Plan I, so as to construct a vault about 4 feet wide, 6 feet long and 5 feet high inside with curved walls uniformly 8 in. in thickness. The brick masonry shall be laid in cement mortar made as specified under Sec. 25, No. 5. Each brick shall be laid in a full bed or mortar upon all sides; there shall be no slushing of joints after bricks are placed. The masonry shall be laid in alternate courses of headers and stretchers. As nearly as may be the center of each end the wall shall be corbelled as shown, to afford entrance for the ducts, but the exact location of the ducts in each wall shall be given by the Engineer or Superintendent at the time of building. The size of the entrance shall depend upon the number of ducts shall be specified for each wall separately. When the mason work has reached the level of the under side of the ducts, the Contractor shall then build the end of the conduit into each end wall, unless the

Engineer or Superintendent shall direct the manhole to be completed, and the conduit to be subsequently built. If such instructions be given, the Contractor shall leave a suitable opening in each end wall and shall proceed to complete the manhole, and after completion he shall build in the conduit.

The four walls shall be carried up uniformly and as they are built the exterior of each wall shall be plastered thoroughly with cement mortar to a thickness of not less than ½ in. The walls shall be built 5 feet high above the top of the concrete bottom, and shall then be levelled off evenly to receive the top. All masonry shall be laid plumb and true to line and level with not over ⅝ in. joints completely filled with cement mortar, accurately curved to templet, as shown, and shall be in every respect first class brick masonry. The roof will vary according to location in the street, and may be either flat or arched, and may be composed either of concrete or brick laid upon iron as shown.

(b) Arched Concrete Roof.

This shall be made by setting inside of the walls and level with the top thereof, an appropriate form so constructed that after the top is completed the form may be withdrawn through the opening for the cover. After this form is in place a layer of concrete eight in. in thickness, shall be placed on the top of the form and thoroughly and solidly rammed into place. This concrete shall be allowed to set for 6 hours before any refilling is made.

(c) Flat Concrete Roof.

Flat concrete roofs shall be made exactly as specified in Sec. 25, No. 13. b., except the form shall be so made as to give a flat not an arched roof.

(d) Brick and Iron Roof.

Brick roofs shall be built by placing across the walls a series of iron beams made of angle iron, as shown on Plan I and as specified in the attached Bill of Materials headed Brick Manholes. If the Contractor desires he may substitute any other equally strong iron shape such as old rail channels, angles, etc., if approved by the Engineer or Superintendent.

(e) Concrete Manholes.

Concrete manholes shall be built of the same general form and shape as shown in Plan I; the bottom shall be put in, in the same manner as specified already, in Sec. 25, 13. a., and after it is in place and has had six hours' time to set, the Contractor shall place thereon the appropriate form for shaping the concrete. This form shall be made of first class dressed lumber accurately and carefully built in a substantial manner, to withstand without deforming the ramming of concrete. It shall be so built as to easily retain its shape and readily taken apart so the largest piece can be removed through the cover hole. The forms shall be smooth and true so that after the concrete is rammed a finished surface be produced. The Contractor shall constantly maintain the forms in good condition so that they shall yield first class manholes. After the form is properly set the Contractor shall deposit around it the necessary concrete to give a wall 8 in. in thickness. This concrete shall be made as specified in Sec. 25, No. 6, and shall be filled around the form in layers not exceeding 6 in. in thickness, thoroughly rammed in place sufficiently to show a slight flushing. The placing of the concrete shall be uniformly and evenly carried around the entire circumference of the form, layer after layer, until the form is completely covered. To retain the outside of the concrete, the Contractor may either use the earth walls of the excavation or sheeting as he may see fit. The concreting shall be continued without stopping so as to complete the entire manhole at a single operation.

After the roof is completed 6 hours shall be allowed for setting, then a ring of brick masonry of sufficient size and height to raise the cover flush and level with the street pavement shall be built around the opening for the cover and the iron cover be set in its place, as shown on Plan I. After the settling of the cover the refilling of the manhole excavation shall be done. In this refilling the excavated material shall be deposited in layers of about 6 in. in thickness uniformly all around the manhole walls and shall be solidly rammed into place. If directed, the Contractor shall puddle all the refill. This refilling shall extend up to and around the cover to the proper height to receive the paving, which shall then be replaced as specified in Sec. 25, No. 11.

(f) Changes in Manholes.

The Engineer or Superintendent shall have the right at any time to change the size and shape of any manhole to any extent that shall in his judgment be deemed expedient. The Contractor shall at all times build such special manholes in accordance with any supplementary drawings, plans or instructions, without extra charge, provided such changes do not require the Contractor to supply a greater amount of masonry or concrete than is called for by Plan I and Bills of Material for standard manhole. In case the directions shall increase the volume of masonry in any manhole, the Engineer or Superintendent shall give to the Contractor an order for all extra material so demanded, and this order shall authorize payment to the Contractor of such an amount as shall cover the difference between the amount of masonry in the standard manhole and that in the one called for. This extra compensation shall be at the rate hereinbefore specified in Sec. 23, No. 6. a. and b.

(g) Sewer Connections.

The bottom of such manholes as the Engineer or Superintendent shall direct shall be provided with a drain connecting with the nearest street sewer. This drain shall be made of a sufficient amount of standard 4 in. tile drain pipe. The Contractor shall supply the required pipe, make the necessary excavation, lay the pipe, connect the outer end thereof to the street sewer, and connect the inner end to a sewer trap approved by the Engineer and Superintendent and set same in manhole floor, and repave the excavation. All of this work shall be done by men holding "Sewer Permits," and shall be in accordance with all the City rules pertaining to sewer connections and to the satisfaction of the City authorities. For all such sewer connections the Contractor shall apply for, take out and pay to the City the usaul fee for a sewer permit, and shall file with the Company the receipt for each and every such connection as evidence of his compliance wtih the City rules.

(h) Treatment of Structures entering Manholes.

The location of the conduits and manholes shall be, at all times, so planned as to avoid, as far as possible, carrying any gas pipes, water pipes, drain pipes, foreign electric subways or other street structures inside of the walls of the manholes, but where it is impossible to avoid the entrance of such structures, the Contractor shall take particular pains in building the walls of the manhole or other parts of the masonry thereof, around such structures. In any instance where gas pipe, water pipe, electric subway, Edison tubes, drain pipes or other structures shall pass through any portion of any manhole, the Contractor shall turn a complete circular arch in the mason work of each wall intersected by such structure entirely around such structure. This arch shall be so built as to give not less than 1½ in. clearance between the foreign structure and the mason work, solidly built of brick set upon edge, laid in cement mortar with closed joints, and shall allow the foreign structure to pass through the manhole wihout touching any portion of the walls thereof.

(i) Pointing of Brick Work; and Entrance of the Ducts.

After each manhole is entirely completed and conduits built into place in each end wall, the Contractor shall go over and finish the same. The finish shall consist in pointing up with neat cement mortar all joints in brick work, and entrance of ducts, and the junction between the masonry of the sides and the bottom and top, the entrance of the sewer trap and the junction of the cover with the manhole top. The pointing shall be done in a neat and workmanlike manner so as to seal and complete all joints. After the pointing is done the manhole shall be thoroughly cleaned out, the bottom-sides and top, including the entrance to the ducts, smoothed off so as to leave the work in a neat and shipshape manner in every respect.

(j) Provision for Rendering Conduit or Manholes Watertight.

In case any conduits or manholes shall be laid in a wet location and where standing water is encountered in the excavation of trenches, the Contractor shall excavate a proper sump and dig along the bottom and outside of the excavation a proper drain and provide sufficient pumping facilities so that such excavation may be kept free from water during the setting of the concrete or masonry. In such cases the Contractor shall take particular pains with the manufacture and placing of concrete so that when the work is completed all portions of the conduits and all the manholes shall be water tight. In case any portion of conduit or any manhole shall after completion be found to leak, the Contractor shall reopen the excavation and plaster, or in any other manner satisfactory to the Engineer or Superintendent stop any and all such leaks or incursions of water.

SECTION 26.

26 Rodding

After the completion of each section of conduit together with the adjacent manholes and each lateral, the Contractor shall *rod* each and every duct. This process shall consist in pushing a series of rods of wood or metal composed of sections of such length as may be handled inside the manhole and arranged to be easily joined together through each duct. These rods shall be supplied by the Contractor. After the rods are pushed through a duct a rope shall be attached to the rear end of the rods to enable a mandrel to be pulled through the duct, in order to ascertain whether the duct is free and clear, and to remove any surplus mortar, concrete or other obstacles which may have entered therein. This

mandrel shall consist of a piece of iron pipe about 2½ in. in diameter, supplied with appropriate hook and eye at either end, to which the proper ropes may be attached, and furnished at both ends with a sharp cutting edge of steel. The mandrel shall also be supplied with a steel brush not less than three inches in diameter. A specimen mandrel will be furnished to the Contractor by the Company and the Contractor shall build and supply as many mandrels, exactly in accordance therewith, as may be necessary. If, during the rodding the Contractor shall find any obstacle that shall prevent the passage of the mandrel, he shall reopen the street, find the obstruction, dislodge the same, repair the conduit, replace the concrete encasement, refill the excavation, replace the pavement, and then shall repeat the process of rodding until the mandrel shall pass easily through each and every duct. After the mandrel has been pulled through each duct, the Contractor shall pull into and leave in such ducts as may be specified by the Engineer or Superintendent a piece of No. 10 B. W. G. galvanized iron wire long enough to extend entirely through each duct and project about 6 in. from each end thereof. The Company shall deliver to the Contractor at its storehouse all the wire that shall be required for the purpose, but the Contractor shall haul the wire to the work and introduce the same into the ducts without extra charge. Finally the Contractor shall plug each end of each duct with a hardwood plug of sufficient size to firmly stop the ends. This plug shall be of hardwood, turned true and smooth, shall so fit the duct that it cannot be forced inside thereof, and shall project at least one inch inside the end of the duct and two inches outside thereof. The plugs shall be soaked in water for at least twelve hours, before they are put in place so that they may not swell and split the ducts.

IN WITNESS whereof the parties to these presents have caused the same to be signed by their respective executive officers and their respective corporate seals to be hereto affixed the day and year first above written.

(Signature first party)

.....

.....

(Signature second party)

.....

.....

(Witnesses)

.....

.....

.....

BOND.

27
Bond

KNOW ALL MEN BY THESE PRESENTS THAT WE .... as principal, and .....we as surety, ...are held and firmly bound unto the..... COMPANY, of....., in the sum of..... .....Dollars, to be paid to the said.....COMPANY, its successors and assigns, for which payment well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors jointly and severally by these presents.

Sealed with our seal and dated at this..... day of ....., 1900.

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH THAT

Whereas the said above bounden..... has entered into a certain agreement of date herewith in which the..... .....is party of the first part, and the said..... .....is the party of the second part, for the full terms used and particulars hereof express reference is hereby made to such agreement, and by this reference it is made a part hereof, to which this bond is annexed.

NOW THEREFORE, if the said ..... shall in all things fully and faithfully keep and perform said agreement and each and every term and part thereof, then this obligation shall be void, otherwise it shall remain in full force.

WITNESS OUR NAMES AND SEALS

..... Seal.
..... Seal.
..... Seal.

(Witnesses)

.....
.....
.....

SECTION 27.

Bills of Material.

(*a*) Concrete manhole, flat concrete roof.

28
Bills of Material

Excavation and removal of earth.	375 cubic feet
Concrete	125 cubic feet
Cover and frame	1
Repaving	6 square yards

(*b*) Concrete manhole arched roof.

Excavation and removal of earth	425 cubic feet
Concrete	130 cubic feet
Cover and frame	1
Repaving	6 square yards

(*c*) Brick manhole flat concrete roof.

Excavation and removal of earth	375 cubic feet
Concrete	52 cubic feet
Brick	1600
Cover and frame	1
Repaving	6 square yards

(*d*) Brick manhole flat brick and iron roof.

Excavation and removal of earth	375 cubic feet
Concrete	19 cubic feet
Brick	2200
Iron work	500 pounds
Cover and frame	1
Repaving	6 square yards

(*e*) Sewer to any manhole (average).

Excavation and refilling	25 cubic feet
4 in. sewer pipe	16 linear feet
4 in. sewer trap	1
Repaving	5 square yards

THE ELECTRICAL WORLD AND ENGINEER'S

MOONLIGHT TABLES FOR 1901.

COMPILED BY H. W. FRUND.

These schedules are made up on local mean time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made.

JANUARY, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	5.15 P.M.	1	12.00 M.
2	5.15 "	2	12.00 "
3	5.15 "	3	12.00 "
4	5.15 "	4	12.00 "
5	5.15 "	5	12.00 "
6	5.15 "	6	12.00 "
7	5.20 "	7	12.00 "
8	5.20 "	8	12.00 "
9	5.20 "	9	12.00 "
10	5.20 "	10	12.00 "
11	5.20 "	12	12.55 A.M.
12	5.25 "	13	1.50 "
13	5.25 "	14	2.45 "
14	5.25 "	15	3.45 "
15	5.25 "	16	4.40 "
16	5.25 "	17	5.35 "
17	5.30 "	18	6.20 "
18	5.30 "	19	6.20 "
19	5.30 "	20	6.20 "
20	5.30 "	21	6.20 "
21	5.35 "	22	6.20 "
22	5.35 "	23	6.20 "
23	5.35 "	24	6.20 "
24	5.35 "	25	6.20 "
25	5.40 "	26	6.20 "
26	5.40 "	27	6.15 "
27	5.40 "	27	12.00 M.
28	12.40 A.M.	28	6.15 A.M.
28	5.40 P.M.	28	12.00 M.
29	1.45 A.M.	29	6.15 A.M.
29	5.45 P.M.	29	12.00 M.
30	2.45 A.M.	30	6.15 A.M.
30	5.45 P.M.	30	12.00 M.
31	5.45 "	31	12.00 M.

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	2.50 A.M.	1	6.20 A.M.
2	3.50 "	2	6.20 "
3	No Light.	3	No Light.
4	"	4	"
5	"	5	"
6	5.15 P.M.	6	8.00 P.M.
7	5.20 "	7	9.00 "
8	5.20 "	8	10.00 "
9	5.20 "	9	11.00 "
10	5.20 "	10	12.00 M.
11	5.20 "	12	12.55 A.M.
12	5.25 "	13	1.50 "
13	5.25 "	14	2.45 "
14	5.25 "	15	3.45 "
15	5.25 "	16	4.40 "
16	5.25 "	17	5.35 "
17	5.30 "	18	6.20 "
18	5.30 "	19	6.20 "
19	5.30 "	20	6.20 "
20	5.30 "	21	6.20 "
21	5.35 "	22	6.20 "
22	5.35 "	23	6.20 "
23	5.35 "	24	6.20 "
24	9.10 "	25	6.20 "
25	10.20 "	26	6.20 "
26	11.30 "	27	6.15 "
27	.....	..	.....
28	12.40 A.M.	28	6.15 "
29	1.45 "	29	6.15 "
30	2.45 "	30	6.15 "
31	3.40 "	31	6.15 "

FEBRUARY, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	5.45 P.M.	1	12.00 M.
2	5.50 "	2	12.00 "
3	5.50 "	3	12.00 "
4	5.50 "	4	12.00 "
5	5.50 "	5	12.00 "
6	5.50 "	6	12.00 "
7	5.55 "	7	12.00 "
8	5.55 "	8	12.00 "
9	5.55 "	10	12.40 A.M.
10	5.55 "	11	1.30 "
11	6.00 "	12	2.30 "
12	6.00 "	13	3.25 "
13	6.00 "	14	4.15 "
14	6.00 "	15	5.05 "
15	6.05 "	16	5.55 "
16	6.05 "	17	5.55 "
17	6.05 "	18	5.55 "
18	6.05 "	19	5.55 "
19	6.10 "	20	5.50 "
20	6.10 "	21	5.50 "
21	6.10 "	22	5.50 "
22	6.10 "	23	5.45 "
23	6.15 "	24	5.45 "
24	6.15 "	25	5.40 "
25	6.15 "	25	12.00 M.
26	12.40 A.M.	26	5.40 A.M.
26	6.15 P.M.	26	12.00 M.
27	1.40 A.M.	27	5.40 A.M.
27	6.15 P.M.	27	12.00 M.
28	2.25 A.M.	28	5.35 A.M.
28	6.20 P.M.	28	12.00 M.

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	No Light.	1	No Light.
2	"	2	"
3	"	3	"
4	5.50 P.M.	4	7.45 P.M.
5	5.50 "	5	8.45 "
6	5.50 "	6	9.45 "
7	5.55 "	7	10.40 "
8	5.55 "	8	11.40 "
9	5.55 "	10	12.40 A.M.
10	5.55 "	11	1.30 "
11	6.00 "	12	2.30 "
12	6.00 "	13	3.25 "
13	6.00 "	14	4.15 "
14	6.00 "	15	5.05 "
15	6.05 "	16	5.55 "
16	6.05 "	17	5.55 "
17	6.05 "	18	5.55 "
18	6.05 "	19	5.55 "
19	6.10 "	20	5.50 "
20	6.10 "	21	5.50 "
21	6.10 "	22	5.50 "
22	9.20 "	23	5.45 "
23	10.30 "	24	5.45 "
24	11.40 "	25	5.40 "
25	.....	..	.....
26	12.40 A.M.	26	5.40 A.M.
27	1.40 "	27	5.40 "
28	2.25 "	28	5.35 "

MARCH, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	3.10 A.M.	1	5.35 A.M.
1	6.20 P.M.	1	12.00 M.
2	6.20 "	2	12.00 "
3	6.20 "	3	12.00 "
4	6.25 "	4	12.00 "
5	6.25 "	5	12.00 "
6	6.25 "	6	12.00 "
7	6.25 "	7	12.00 "
8	6.25 "	8	12.00 "
9	6.30 "	9	12.00 "
10	6.30 "	11	12.20 A.M.
11	6.30 "	12	1.10 "
12	6.30 "	13	2.00 "
13	6.35 "	14	2.50 "
14	6.35 "	15	3.40 "
15	6.35 "	16	4.20 "
16	6.35 "	17	5.10 "
17	6.35 "	18	5.10 "
18	6.40 "	19	5.10 "
19	6.40 "	20	5.05 "
20	6.40 "	21	5.05 "
21	6.40 "	22	5.05 "
22	6.40 "	23	5.00 "
23	6.45 "	24	5.00 "
24	6.45 "	25	5.00 "
25	6.45 "	26	5.00 "
26	6.45 "	27	4.55 "
27	6.45 "	27	12.00 M.
28	1.10 A.M.	28	4.55 A.M.
28	6.50 P.M.	28	12.00 M.
29	1.45 A.M.	29	4.50 A.M.
29	6.50 P.M.	29	12.00 M.
30	2.20 A.M.	30	4.50 A.M.
30	6.50 P.M.	30	12.00 M.
..	6.50 "	..	12.00 "

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	3.10 A.M.	1	5.35 A.M.
2	3.40 "	2	5.35 "
3	No Light.	3	No Light.
4	"	4	"
5	"	5	"
6	6.25 P.M.	6	8.30 P.M.
7	6.25 "	7	9.30 "
8	6.25 "	8	10.25 "
9	6.30 "	9	11.20 "
10	6.30 "	11	12.20 A.M.
11	6.30 "	12	1.10 "
12	6.30 "	13	2.00 "
13	6.35 "	14	2.50 "
14	6.35 "	15	3.40 "
15	6.35 "	16	4.20 "
16	6.35 "	17	5.10 "
17	6.35 "	18	5.10 "
18	6.40 "	19	5.10 "
19	6.40 "	20	5.05 "
20	6.40 "	21	5.05 "
21	6.40 "	22	5.05 "
22	6.40 "	23	5.00 "
23	6.40 "	24	5.00 "
24	10.30 "	25	5.00 "
25	11.30 "	26	5.00 "
26	.....	..	.....
27	12.20 A.M.	27	4.55 A.M.
28	1.10 "	28	4.55 "
29	1.45 "	29	4.50 "
30	2.20 "	30	4.50 "
31	2.50 "	31	4.50 "

APRIL, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	6.50 P.M.	1	12.00 M.
2	6.55 "	2	12.00 "
3	6.55 "	3	12.00 "
4	6.55 "	4	12.00 "
5	6.55 "	5	12.00 "
6	6.55 "	6	12.00 "
7	7.00 "	7	12.00 "
8	7.00 "	8	12.00 "
9	7.00 "	10	12.50 A.M.
10	7.00 "	11	1.35 "
11	7.00 "	12	2.15 "
12	7.05 "	13	2.50 "
13	7.05 "	14	3.30 "
14	7.05 "	15	4.00 "
15	7.05 "	16	4.20 "
16	7.05 "	17	4.20 "
17	7.10 "	18	4.20 "
18	7.10 "	19	4.20 "
19	7.10 "	20	4.20 "
20	7.10 "	21	4.15 "
21	7.10 "	22	4.15 "
22	7.15 "	23	4.15 "
23	7.15 "	24	4.10 "
24	7.15 "	25	4.10 "
25	7.15 "	26	4.10 "
26	7.15 "	26	12.00 M.
27	12.50 A.M.	27	4.10 A.M.
27	7.20 P.M.	27	12.00 M.
28	1.20 A.M.	28	4.10 A.M.
28	7.20 P.M.	28	12.00 M.
29	1.50 A.M.	29	4.05 A.M.
29	7.20 P.M.	29	12.00 M.
30	7.20 "	30	12.00 "

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	No Light.	1	No Light.
2	"	2	"
3	"	3	"
4	6.55 P.M.	4	8.20 P.M.
5	6.55 "	5	9.15 "
6	6.55 "	6	10.10 "
7	7.00 "	7	11.10 "
8	7.00 "	8	12.00 M.
9	7.00 "	10	12.50 A.M.
10	7.00 "	11	1.35 "
11	7.00 "	12	2.15 "
12	7.05 "	13	2.50 "
13	7.05 "	14	3.30 "
14	7.05 "	15	4.00 "
15	7.05 "	16	4.20 "
16	7.05 "	17	4.20 "
17	7.10 "	18	4.20 "
18	7.10 "	19	4.20 "
19	7.10 "	20	4.20 "
20	7.10 "	21	4.15 "
21	7.10 "	22	4.15 "
22	10.15 "	23	4.15 "
23	11.00 "	24	4.10 "
24	11.45 "	25	4.10 "
25	.....	..	.....
26	12.20 A.M.	26	4.10 "
27	12.50 "	27	4.10 "
28	1.20 "	28	4.10 "
29	1.50 "	29	4.05 "
30	2.15 "	30	4.05 "

MAY, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	7.20 P.M.	1	12.00 M.
2	7.20 "	2	12.00 "
3	7.25 "	3	12.00 "
4	7.25 "	4	12.00 "
5	7.25 "	5	12.00 "
6	7.25 "	6	12.00 "
7	7.25 "	7	12.00 "
8	7.30 "	9	12.15 A.M.
9	7.30 "	10	12.50 "
10	7.30 "	11	1.30 "
11	7.30 "	12	2.00 "
12	7.30 "	13	2.40 "
13	7.35 "	14	3.10 "
14	7.35 "	15	3.45 "
15	7.35 "	16	3.45 "
16	7.35 "	17	3.45 "
17	7.35 "	18	3.45 "
18	7.40 "	19	3.45 "
19	7.40 "	20	3.45 "
20	7.40 "	21	3.45 "
21	7.40 "	22	3.40 "
22	7.40 "	23	3.40 "
23	7.45 "	24	3.40 "
24	7.45 "	25	3.40 "
25	7.45 "	26	3.40 "
26	7.45 "	27	3.40 "
27	7.45 "	27	12.00 M.
28	12.50 A.M.	28	3.40 A.M.
28	7.45 P.M.	28	12 M.
29	1.15 A.M.	29	3.35 A.M.
29	7.45 P.M.	29	12.00 M.
30	7.50 "	30	12.00 "
31	7.50 "	31	12.00 "

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	2.45 A.M.	1	4.05 A.M.
2	No Light.	2	No Light.
3	"	3	"
4	"	4	"
5	7.25 P.M.	5	9.55 P.M.
6	7.25 "	6	10.45 "
7	7.25 "	7	11.30 "
8	7.30 "	9	12.15 A.M.
9	7.30 "	10	12.50 "
10	7.30 "	11	1.30 "
11	7.30 "	12	2.00 "
12	7.30 "	13	2.40 "
13	7.35 "	14	3.10 "
14	7.35 "	15	3.45 "
15	7.35 "	16	3.45 "
16	7.35 "	17	3.45 "
17	7.35 "	18	3.45 "
18	7.40 "	19	3.45 "
19	7.40 "	20	3.45 "
20	7.40 "	21	3.45 "
21	9.40 "	22	3.40 "
22	10.20 "	23	3.40 "
23	10.50 "	24	3.40 "
24	11.20 "	25	3.40 "
25	11.50 "	26	3.40 "
26	.....	..	.....
27	12.20 A.M.	27	3.40 A.M.
28	12.50 "	28	3.40 "
29	1.15 "	29	3.35 "
30	1.50 "	30	3.35 "
31	No Light.	31	No Light.

JUNE, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	7.50 P.M.	1	12.00 M.
2	7.50 "	2	12.00 "
3	7.50 "	3	12.00 "
4	7.50 "	4	12.00 "
5	7.50 "	5	12.00 "
6	7.55 "	6	12.00 "
7	7.55 "	7	12.00 "
8	7.55 "	9	12.40 A.M.
9	7.55 "	10	1.10 "
10	7.55 "	11	1.40 "
11	7.55 "	12	2.20 "
12	7.55 "	13	3.00 "
13	7.55 "	14	3.30 "
14	7.55 "	15	3.30 "
15	7.55 "	16	3.30 "
16	7.55 "	17	3.30 "
17	8.00 "	18	3.30 "
18	8.00 "	19	3.30 "
19	8.00 "	20	3.30 "
20	8.00 "	21	3.30 "
21	8.00 "	22	3.30 "
22	8.00 "	23	3.30 "
23	8.00 "	24	3.30 "
24	8.00 "	25	3.30 "
25	8.00 "	26	3.30 "
26	8.00 "	27	3.30 "
27	8.00 "	27	12.00 M.
28	8.00 "	28	12.00 "
29	8.00 "	29	12.00 "
30	8.00 "	30	12.00 "

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	No Light.	1	No Light.
2	"	2	"
3	7.50 P.M.	3	9.30 P.M.
4	7.50 "	4	10.15 "
5	7.50 "	5	10.50 "
6	7.55 "	6	11.30 "
7	7.55 "	7	12.00 M.
8	7.55 "	9	12.40 A.M.
9	7.55 "	10	1.10 "
10	7.55 "	11	1.40 "
11	7.55 "	12	2.20 "
12	7.55 "	13	3.00 "
13	7.55 "	14	3.30 "
14	7.55 "	15	3.30 "
15	7.55 "	16	3.30 "
16	7.55 "	17	3.30 "
17	8.00 "	18	3.30 "
18	8.00 "	19	3.30 "
19	8.00 "	20	3.30 "
20	9.20 "	21	3.30 "
21	9.50 "	22	3.30 "
22	10.20 "	23	3.30 "
23	10.50 "	24	3.30 "
24	11.10 "	25	3.30 "
25	11.50 "	26	3.30 "
26	.....	..	.....
27	12.20 A.M.	27	3.30 "
28	1.00 "	28	3.35 "
29	1.40 "	29	3.35 "
30	2.20 "	30	3.35 "

JULY, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	8.00 P.M.	1	12.00 M.
2	8.00 "	2	12.00 "
3	8.00 "	3	12.00 "
4	8.00 "	4	12.00 "
5	8.00 "	5	12.00 "
6	8.00 "	6	12.00 "
7	8.00 "	7	12.00 "
8	8.00 "	9	12.20 A.M.
9	8.00 "	10	1.00 "
10	8.00 "	11	1.40 "
11	8.00 "	12	2.30 "
12	8.00 "	13	3.20 "
13	8.00 "	14	3.40 "
14	8.00 "	15	3.40 "
15	8.00 "	16	3.40 "
16	8.00 "	17	3.40 "
17	8.00 "	18	3.45 "
18	8.00 "	19	3.45 "
19	8.00 "	20	3.45 "
20	7.55 "	21	3.45 "
21	7.55 "	22	3.45 "
22	7.55 "	23	3.45 "
23	7.55 "	24	3.50 "
24	7.55 "	25	3.50 "
25	7.55 "	26	3.50 "
26	7.50 "	27	3.50 "
27	7.50 "	27	12.00 M.
28	7.50 "	28	12.00 "
29	7.50 "	29	12.00 "
30	7.50 "	30	12.00 "
31	7.45 "	31	12.00 "

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	No Light.	1	No Light.
2	"	2	"
3	"	3	"
4	8.00 P.M.	4	10.10 P.M.
5	8.00 "	5	10.40 "
6	8.00 "	6	11.15 "
7	8.00 "	7	11.50 "
8	8.00 "	9	12.20 A.M.
9	8.00 "	10	1.00 "
10	8.00 "	11	1.40 "
11	8.00 "	12	2.30 "
12	8.00 "	13	3.20 "
13	8.00 "	14	3.40 "
14	8.00 "	15	3.40 "
15	8.00 "	16	3.40 "
16	8.00 "	17	3.40 "
17	8.00 "	18	3.45 "
18	8.00 "	19	3.45 "
19	8.00 "	20	3.45 "
20	7.55 "	21	3.45 "
21	9.20 "	22	3.45 "
22	9.50 "	23	3.45 "
23	10.20 "	24	3.50 "
24	10.50 "	25	3.50 "
25	11.35 "	26	3.50 "
26	.....	..	.....
27	12.20 A.M.	27	3.50 "
28	1.10 "	28	3.50 "
29	2.10 "	29	3.50 "
30	No Light.	30	No Light.
31	"	31	"

AUGUST, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	7.45 P.M.	1	12.00 M.
2	7.45 "	2	12.00 "
3	7.45 "	3	12.00 "
4	7.45 "	4	12.00 "
5	7.40 "	5	12.00 "
6	7.40 "	6	12.00 "
7	7.40 "	8	12.30 A.M.
8	7.40 "	9	1.20 "
9	7.40 "	10	2.15 "
10	7.35 "	11	3.15 "
11	7.35 "	12	4.05 "
12	7.35 "	13	4.05 "
13	7.30 "	14	4.05 "
14	7.30 "	15	4.10 "
15	7.30 "	16	4.10 "
16	7.30 "	17	4.10 "
17	7.25 "	18	4.10 "
18	7.25 "	19	4.10 "
19	7.25 "	20	4.15 "
20	7.20 "	21	4.15 "
21	7.20 "	22	4.15 "
22	7.20 "	23	4.15 "
23	7.20 "	24	4.15 "
24	7.15 "	25	4.20 "
25	7.15 "	25	12.00 M.
26	7.15 "	26	12.00 "
27	7.15 "	27	12.00 "
28	7.10 "	28	12.00 "
29	7.10 "	29	12.00 "
30	7.10 "	30	12.00 "
31	7.05 "	31	12.00 "

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	No Light.	1	No Light.
2	7.45 P.M.	2	9.20 P.M.
3	7.45 "	3	9.50 "
4	7.45 "	4	10.20 "
5	7.40 "	5	11.00 "
6	7.40 "	6	11.40 "
7	7.40 "	8	12.30 A.M.
8	7.40 "	9	1.20 "
9	7.40 "	10	2.15 "
10	7.35 "	11	3.15 "
11	7.35 "	12	4.05 "
12	7.35 "	13	4.05 "
13	7.30 "	14	4.05 "
14	7.30 "	15	4.10 "
15	7.30 "	16	4.10 "
16	7.30 "	17	4.10 "
17	7.25 "	18	4.10 "
18	7.25 "	19	4.10 "
19	7.25 "	20	4.15 "
20	8.50 "	21	4.15 "
21	9.30 "	22	4.15 "
22	10.15 "	23	4.15 "
23	11.00 "	24	4.15 "
24	12.00 M.	25	4.20 "
25	.....	..	.....
26	1.00 A.M.	26	4.20 "
27	2.00 "	27	4.20 "
28	No Light.	28	No Light.
29	"	29	"
30	"	30	"
31	7.05 P.M.	31	8.30 P.M.

SEPTEMBER, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	7.05 P.M.	1	12.00 M.
2	7.05 "	2	12.00 "
3	7.00 "	3	12.00 "
4	7.00 "	4	12.00 "
5	7.00 "	6	12.10 A.M.
6	6.55 "	7	1.10 "
7	6.55 "	8	2.10 "
8	6.55 "	9	3.15 "
9	6.50 "	10	4.20 "
10	6.50 "	11	4.35 "
11	6.50 "	12	4.35 "
12	6.50 "	13	4.35 "
13	6.45 "	14	4.35 "
14	6.45 "	15	4.35 "
15	6.40 "	16	4.40 "
16	6.40 "	17	4.40 "
17	6.40 "	18	4.40 "
18	6.35 "	19	4.40 "
19	6.35 "	20	4.40 "
20	6.35 "	21	4.45 "
21	6.30 "	22	4.45 "
22	6.30 "	23	4.45 "
23	6.30 "	23	12.00 M.
24	12.40 A.M.	24	4.45 A.M.
24	6.25 P.M.	24	12.00 M.
25	6.25 "	25	12.00 "
26	6.25 "	26	12.00 "
27	6.25 "	27	12.00 "
28	6.20 "	28	12.00 "
29	6.20 "	29	12.00 "
30	6.20 "	30	12.00 "

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	7.05 P.M.	1	9.00 P.M.
2	7.05 "	2	9.40 "
3	7.00 "	3	10.25 "
4	7.00 "	4	11.15 "
5	7.00 "	6	12.10 A.M.
6	6.55 "	7	1.10 "
7	6.55 "	8	2.10 "
8	6.55 "	9	3.15 "
9	6.50 "	10	4.20 "
10	6.50 "	11	4.35 "
11	6.50 "	12	4.35 "
12	6.50 "	13	4.35 "
13	6.45 "	14	4.35 "
14	6.45 "	15	4.35 "
15	6.40 "	16	4.40 "
16	6.40 "	17	4.40 "
17	6.40 "	18	4.40 "
18	8.10 "	19	4.40 "
19	9.00 "	20	4.40 "
20	9.45 "	21	4.45 "
21	10.40 "	22	4.45 "
22	11.40 "	23	4.45 "
23	.....	..	.....
24	12.40 A.M.	24	4.45 "
25	1.40 "	24	4.50 "
26	2.50 "	26	4.50 "
27	No Light.	27	No Light.
28	"	28	"
29	"	29	"
30	6.20 P.M.	30	8.20 P.M.

OCTOBER, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.

NOVEMBER, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.

DECEMBER, 1901.

TABLE No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.

TABLE No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.

25	7.55 "	26	3.50 "	25	11.35 "	26	3.50 "	25	7.15 "	25	12.00 M.	25	.....	..	....	24	6.25 P.M.	24	12.00 M.	25	1.40 "	25	4.50 "
26	7.50 "	27	3.50 "	26	.....	..	.....	26	7.15 "	26	12.00 "	26	1.00 A.M.	26	4.20 "	25	6.25 "	25	12.00 "	26	2.50 "	26	4.50 "
27	7.50 "	27	12.00 M.	27	12.20 A.M.	27	3.50 "	27	7.15 "	27	12.00 "	27	2.00 "	27	4.20 "	26	6.25 "	26	12.00 "	27	No Light.	27	No Light.
28	7.50 "	28	12.00 "	28	1.10 "	28	3.50 "	28	7.10 "	28	12.00 "	28	No Light.	28	No Light.	27	6.25 "	27	12.00 "	28	"	28	"
29	7.50 "	29	12.00 "	29	2.10 "	29	3.50 "	29	7.10 "	29	12.00 "	29	"	29	"	28	6.20 "	28	12.00 "	29	"	29	"
30	7.50 "	30	12.00 "	30	No Light.	30	No Light.	30	7.10 "	30	12.00 "	30	"	30	"	29	6.20 "	29	12.00 "	30	6.20 P.M.	30	8.20 P.M.
31	7.45 "	31	12.00 "	31	"	31	"	31	7.05	31	12.00 "	31	7.05 P.M.	31	8.30 P.M.	30	6.20 "	30	12.00 "				

OCTOBER, 1901.

TABLE No. 1.
Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	6.15 P.M.	1	12.00 M.
2	6.15 "	2	12.00 "
3	6.15 "	3	12.00 "
4	6.10 "	4	12.00 "
5	6.10 "	6	1.10 A.M.
6	6.10 "	7	2.15 "
7	6.05 "	8	3.15 "
8	6.05 "	9	4.15 "
9	6.05 "	10	5.05 "
10	6.00 "	11	5.05 "
11	6.00 "	12	5.05 "
12	6.00 "	13	5.05 "
13	5.55 "	14	5.05 "
14	5.55 "	15	5.10 "
15	5.50 "	16	5.10 "
16	5.50 "	17	5.10 "
17	5.50 "	18	5.10 "
18	5.50 "	19	5.10 "
19	5.45 "	20	5.10 "
20	5.45 "	21	5.15 "
21	5.45 "	22	5.15 "
22	5.45 "	22	12.00 M.
23	12.30 A.M.	23	5.15 A.M.
23	5.40 P.M.	23	12.00 M.
24	1.40 A.M.	24	5.15 A.M.
24	5.40 P.M.	24	12.00 M.
25	5.40 "	25	12.00 "
26	5.40 "	26	12.00 "
27	5.35 "	27	12.00 "
28	5.35 "	28	12.00 "
29	5.35 "	29	12.00 "
30	5.35 "	30	12.00 "
31	5.30 "	31	12.00 "

TABLE No. 2.
Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	6.15 P.M.	1	9.10 P.M.
2	6.15 "	2	10.10 "
3	6.15 "	3	11.00 "
4	6.10 "	4	12.00 M.
5	6.10 "	6	1.10 A.M.
6	6.10 "	7	2.15 "
7	6.05 "	8	3.15 "
8	6.05 "	9	4.15 "
9	6.05 "	10	5.05 "
10	6.00 "	11	5.05 "
11	6.00 "	12	5.05 "
12	6.00 "	13	5.05 "
13	5.55 "	14	5.05 "
14	5.55 "	15	5.10 "
15	5.50 "	16	5.10 "
16	5.50 "	17	5.10 "
17	5.50 "	18	5.10 "
18	8.30 "	19	5.10 "
19	9.30 "	20	5.10 "
20	10.30 "	21	5.15 "
21	11.30 "	22	5.15 "
22	.....	..	....
23	12.30 A.M.	23	5.15 "
24	1.40 "	24	5.15 "
25	2.50 "	25	5.20 "
26	4.00 "	26	5.20 "
27	No Light.	27	No Light.
28	"	28	"
29	5.35 P.M.	29	7.50 P.M.
30	5.35 "	30	8.50 "
31	5.30 "	31	10.00 "

NOVEMBER, 1901.

TABLE No. 1.
Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	5.30 P.M.	1	12.00 M.
2	5.30 "	2	12.00 "
3	5.30 "	4	1.10 A.M.
4	5.25 "	5	2.10 "
5	5.25 "	6	3.10 "
6	5.25 "	7	4.10 "
7	5.25 "	8	5.10 "
8	5.25 "	9	5.35 "
9	5.20 "	10	5.35 "
10	5.20 "	11	5.40 "
11	5.20 "	12	5.40 "
12	5.20 "	13	5.40 "
13	5.20 "	14	5.40 "
14	5.15 "	15	5.40 "
15	5.15 "	16	5.45 "
16	5.15 "	17	5.45 "
17	5.15 "	18	5.45 "
18	5.15 "	19	5.45 "
19	5.15 "	20	5.45 "
20	5.10 "	20	12.00 M.
21	12.30 A.M.	21	5.50 A.M.
21	5.10 P.M.	21	12.00 M.
22	1.40 A.M.	22	5.50 A.M.
22	5.10 P.M.	22	12.00 M.
23	5.10 "	23	12.00 "
24	5.10 "	24	12.00 "
25	5.10 "	25	12.00 "
26	5.10 "	26	12.00 "
27	5.10 "	27	12.00 "
28	5.10 "	28	12.00 "
29	5.10 "	29	12.00 "
30	5.05 "	30	12.00 "

TABLE No. 2.
Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	5.30 P.M.	1	11.00 P.M.
2	5.30 "	2	12.00 M.
3	5.30 "	4	1.10 A.M.
4	5.25 "	5	2.10 "
5	5.25 "	6	3.10 "
6	5.25 "	7	4.10 "
7	5.25 "	8	5.10 "
8	5.25 "	9	5.35 "
9	5.20 "	10	5.35 "
10	5.20 "	11	5.40 "
11	5.20 "	12	5.40 "
12	5.20 "	13	5.40 "
13	5.20 "	14	5.40 "
14	5.15 "	15	5.40 "
15	5.15 "	16	5.45 "
16	8.20 "	17	5.45 "
17	9.20 "	18	5.45 "
18	10.20 "	19	5.45 "
19	11.20 "	20	5.45 "
20	.....	..	....
21	12.30 A.M.	21	5.50 "
22	1.40 "	22	5.50 "
23	2.50 "	23	5.50 "
24	4.00 "	24	5.50 "
25	No Light.	25	No Light.
26	"	26	"
27	5.10 P.M.	27	7.35 P.M.
28	5.10 "	28	8.40 "
29	5.10 "	29	9.50 "
30	5.05 "	30	10.55 "

DECEMBER, 1901.

TABLE No. 1.
Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	5.05 P.M.	1	12.00 M.
2	5.05 "	3	1.00 A.M.
3	5.05 "	4	2.00 "
4	5.05 "	5	3.00 "
5	5.05 "	6	4.00 "
6	5.05 "	7	5.00 "
7	5.05 "	8	5.50 "
8	5.05 "	9	6.10 "
9	5.05 "	10	6.10 "
10	5.05 "	11	6.10 "
11	5.05 "	12	6.10 "
12	5.05 "	13	6.10 "
13	5.05 "	14	6.10 "
14	5.05 "	15	6.10 "
15	5.05 "	16	6.15 "
16	5.05 "	17	6.15 "
17	5.05 "	18	6.15 "
18	5.05 "	19	6.15 "
19	5.05 "	19	12.00 M.
20	12.30 A.M.	20	6.15 A.M.
20	5.05 P.M.	20	12.00 M.
21	1.40 A.M.	21	6.15 A.M.
21	5.05 P.M.	21	12.00 M.
22	5.05 "	22	12.00 "
23	5.05 "	23	12.00 "
24	5.05 "	24	12.00 "
25	5.10 "	25	12.00 "
26	5.10 "	26	12.00 "
27	5.10 "	27	12.00 "
28	5.10 "	28	12.00 "
29	5.10 "	29	12.00 "
30	5.10 "	30	12.00 "
31	5.10 "	31	12.50 A.M.

TABLE No. 2.
Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	5.05 P.M.	1	12.00 M.
2	5.05 "	3	1.00 A.M.
3	5.05 "	4	2.00 "
4	5.05 "	5	3.00 "
5	5.05 "	6	4.00 "
6	5.05 "	7	5.00 "
7	5.05 "	8	5.50 "
8	5.05 "	9	6.10 "
9	5.05 "	10	6.10 "
10	5.05 "	11	6.10 "
11	5.05 "	12	6.10 "
12	5.05 "	13	6.10 "
13	5.05 "	14	6.10 "
14	5.05 "	15	6.10 "
15	8.10 "	16	6.15 "
16	9.15 "	17	6.15 "
17	10.20 "	18	6.15 "
18	11.20 "	19	6.15 "
19	.....	..	....
20	12.30 A.M.	20	6.15 "
21	1.40 "	21	6.15 "
22	2.50 "	22	6.15 "
23	4.00 "	23	6.15 "
24	No Light.	24	No Light.
25	"	25	"
26	5.10 P.M.	26	7.30 P.M.
27	5.10 "	27	8.35 "
28	5.10 "	28	9.40 "
29	5.10 "	29	10.45 "
30	5.10 "	30	11.50 "
31	5.10 "	31	12.50 A.M.

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